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*** While Chemwatch has taken all efforts to ensure the accuracy of information in this publication, it is not intended to be comprehensive or to render advice. Websites rendered are subject to change.**

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ASIA PACIFIC

Chemicals added to the Inventory 5 years after issue of assessment certificate

2022-02-18

The following industrial chemicals have been added to the Inventory in accordance with section 82 of the Industrial Chemicals Act 2019 because 5 years have passed since the assessment certificates for the industrial chemicals were issued.

A list of chemicals added to the Inventory 5 years after issue of assessment certificate:

CAS Number	1568954-90-4
Chemical Name	Polyphosphoric acids, esters with triethanolamine, compds. with alkylpyridines
Molecular Formula	Unspecified
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	3 February 2022
CAS Number	2415016-06-5
Chemical Name	1,4-Benzenedisulfonic acid, 2-[[4-[[3-amino-4-[(3-sulfopropyl)thio]phenyl]amino]-6-[(2-sulfoethyl)amino]-1,3,5-triazin-2-yl]amino]-, sodium salt (1:4), diazotized, coupled with 4-(aminocarbonyl)-1-hydroxy-7-methoxy-3-methylpyrido[1,2-a]benzimidazole-8-sulfonic acid, 4-(aminocarbonyl)-1-hydroxy-8-methoxy-3-methylpyrido[1,2-a]benzimidazole-7-sulfonic acid, 4-cyano-1-hydroxy-7-methoxy-3-methylpyrido[1,2-a]benzimidazole-8-sulfonic acid, 4-cyano-1-hydroxy-8-methoxy-3-methylpyrido[1,2-a]benzimidazole-7-sulfonic acid, diazotized 3-(2-amino-4-methylphenoxy)-1-propanesulfonic acid, diazotized sodium 2-[2-[2-(acetylamino)-4-amino-5-[(3-sulfopropyl)thio]phenyl]diazenyl]-5-nitrobenzenesulfonate (2:1), diazotized sodium 2-amino-5-nitrobenzenesulfonate (1:1), lithium sodium salts
Molecular Formula	Unspecified

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CAS Number	1568954-90-4
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 February 2022
CAS Number	1961246-11-6
Chemical Name	2-Propenoic acid, 2-methyl-, polymer with ethenylbenzene, 2-ethylhexyl 2-methyl-2-propenoate, 2-hydroxyethyl 2-propenoate and methyl 2-methyl-2-propenoate, bis(1,1-dimethylpropyl) peroxide-initiated
Molecular Formula	Unspecified
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 February 2022
CAS Number	1542830-43-2
Chemical Name	2-Propenoic acid, 2-methyl-, butyl ester, polymer with 2-ethylhexyl 2-propenoate, methyl 2-methyl-2-propenoate and rel-(1R,2R,4R)-1,7,7-trimethylbicyclo[2.2.1]hept-2-yl 2-methyl-2-propenoate, 2,2 -(1,2-diazenediyl)bis[2-methylbutanenitrile]-initiated
Molecular Formula	Unspecified
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 February 2022
CAS Number	1315177-45-7
Chemical Name	Propanoic acid, 3-hydroxy-2,2-dimethyl-, 3-hydroxy-2,2-dimethylpropyl ester, polymer with 1,4-cyclohexanedimethanol, 1,3-cyclohexanedimethanol, 2-ethyl-2-(hydroxymethyl)-1,3-propanediol, hexahydro-1,3-isobenzofurandione and 2-oxepanone
Molecular Formula	$(C_{10}H_{20}O_4 \cdot C_8H_{16}O_2 \cdot C_8H_{16}O_2 \cdot C_8H_{10}O_3 \cdot C_6H_{14}O_3 \cdot C_6H_{10}O_2)_x$
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	14 February 2022

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CAS Number	1568954-90-4
CAS Number	1956326-43-4
Chemical Name	D-Glucitol, 1,4:3,6-dianhydro-, mixed esters with octanoic acid and sorbitan
Molecular Formula	Unspecified
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 February 2022
CAS Number	1659307-53-5
Chemical Name	1-Propanaminium, N,N,N-trimethyl-3-[(1-oxo-2-propen-1-yl)amino]-, chloride (1:1), polymer with ethenamine and 2-propenamide, hydrochloride
Molecular Formula	$(C_9H_{19}N_2O \cdot C_3H_5NO \cdot C_2H_5N \cdot Cl)_x \cdot xClH$
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 February 2022
CAS Number	913068-94-7
Chemical Name	2-Propen-1-aminium, N,N-dimethyl-N-2-propen-1-yl-, chloride (1:1), polymer with 2-propenamide, decarbonylated, hydrochlorides
Molecular Formula	Unspecified
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 February 2022

Australia Industrial Chemicals, 18 February 2022

<https://www.industrialchemicals.gov.au/news-and-notice/chemicals-added-inventory-5-years-after-issue-assessment-certificate-18-february-2022>

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Vietnam Implements New POPs Regulations under Decree No. 08/2022/ND-CP of LEP

2022-02-17

On November 17, 2020, Vietnam released the revised Law on Environmental Protection (2020 LEP) to replace its 2014 version. The 2020 LEP took effect on January 1, 2022. Besides some notable new changes concerning environmental impact assessment, environment permits and registration, environmental audit, etc., the law adopts new requirements on persistent organic pollutants (POPs) and raw materials, fuels, materials, products, goods and equipment containing POPs (hereinafter “products containing POPs”). This is in line with Vietnam’s commitment to protect the environment under UN Stockholm Convention.

[Read More](#)

Chemlinked, 17 February 2022

<https://chemical.chemlinked.com/news/chemical-news/vietnam-implements-new-pops-regulations-under-decree-no-082022nd-cp-of-lep>

Taiwan Approves the Use of Ganoderma Microsporium Globulin-like Protein Concentrate as a Food Ingredient

2022-02-18

On Feb 16, 2022, Taiwan FDA sets the use restriction and labeling requirement for *Ganoderma microsporium* globulin-like protein concentrate as a food ingredient produced by genetically modified *Pichia pastoris* Ey72.

Food products containing *Ganoderma microsporium* globulin-like protein concentrate produced by *Pichia pastoris* Ey72 shall bear the following warning statement: Children under twelve years old, pregnant women, lactating women and people with allergies shall avoid consuming.

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[Read More](#)

Chemlinked, 18 February 2022

<https://food.chemlinked.com/news/food-news/taiwan-approves-the-use-of-ganoderma-microsporium-globulin-like-protein-concentrate-as-a-food-ingredient>

AMERICA

EPA Seeks Input From Small Businesses on Proposed PFAS Reporting Rule

2022-02-04

The Environmental Protection Agency on February 2 announced the formation of a Small Business Advocacy Review Panel to offer feedback on a forthcoming rule that will require regulated entities to disclose detailed information on per- and polyfluoroalkyl substance usage since 2011. EPA is forming the panel partly in response to public comments expressing concern with the capability of smaller entities to comply with the proposed rule, which is set to be finalized on or before January 1, 2023. If promulgated without significant revision, the draft rule could create heavy burdens for regulated entities.

Unlike similar chemical reporting requirements found elsewhere in the Toxic Substances Control Act (TSCA),^[1] a draft version of the per- and polyfluoroalkyl substances (PFAS) reporting rule^[2] that EPA released for public comment in June 2021—discussed in our LawFlash, [Environmental Protection Agency Announces Three New Actions on PFAS](#)—does not exempt small businesses or de minimis PFAS “producers” (defined to include manufacturers and importers).

IMPACT ON REGULATED ENTITIES

If finalized in its current form, the draft rule could create heavy burdens for regulated entities in several key respects:

- While similar chemical reporting requirements under TSCA are limited to the chemical products themselves, the PFAS reporting rule would apply to “articles” containing PFAS chemicals as well. Thus, it is not just the original chemical manufacturer that is required to report under the draft rule, but also downstream producers who use those chemicals to create other products or who import such products.

The Environmental Protection Agency on February 2 announced the formation of a Small Business Advocacy Review Panel to offer feedback on a forthcoming rule that will require regulated entities to disclose detailed information on per- and polyfluoroalkyl substance usage since 2011.

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- The rule incorporates a broad definition of “PFAS” that includes at least 1,346 known chemical structures, and possibly more. Taken together with the fact that many PFAS chemicals have properties that make them useful in consumer goods and other applications (e.g., durability, moisture repellency, heat resistance), it is common to find “PFAS” (as defined in the proposed rule) in a vast range of products.
- The rule requires that regulated entities disclose a substantial amount of information for each PFAS chemical used since January 2011. Reports must include not only the identities of PFAS chemicals and amounts used, but also by-products resulting from manufacturing, use, or disposal; potential environmental and health effects of each substance; the manner of disposal; and the number of individuals potentially exposed, as well as the duration of such exposure. Where this information is not readily available, regulated entities are expected to conduct an investigation to find it, provide estimates, and/or document efforts to obtain it.

Taken as a whole, the draft regulations impose significant reporting obligations on a very large pool of businesses that manufactured or imported a wide variety of articles since 2011. These obligations could be particularly taxing on small businesses and others that may not have in-house environmental expertise.

EPA OPEN TO EASING COMPLIANCE BURDENS ON SMALLER ENTITIES

At the time it published the draft rule for public comment, EPA noted that while it cannot exempt smaller manufacturers and importers of PFAS or PFAS-containing products from the reporting rule entirely, it could consider ways to ease their compliance burdens.

The formation of the Small Business Advocacy Review Panel (SBAR Panel) is a step in that direction, and an opportunity for those entities to address some of the more impactful components of the draft rule. The panel will be composed of Small Entity Representatives (SERS) (which may include delegates from small businesses, small governments, nonprofit organizations, and trade associations) and federal government representatives from the Small Business Administration, the Office of Management and Budget, and EPA.^[3]

[Read More](#)

Morgan Lewis, 4 February 2022

<https://www.morganlewis.com/pubs/2022/02/epa-seeks-input-from-small-businesses-on-proposed-pfas-reporting-rule>

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Thousands evacuated after US fertilizer plant fire sparked fears of explosion

2022-02-05

About 6,500 people were under evacuation orders for three days after a fire broke out at a [North Carolina](#) fertilizer plant, which officials said risked becoming one of the biggest explosions ever to occur in the US.

The fire continues to burn. The plant contains roughly 600 tons of ammonium nitrate, a highly volatile chemical compound that is used to make both fertilizers and explosives.

The Winston-Salem fire erupted in the northern part of the city of 250,000 on Monday, though the cause remains unknown. Roughly 2,500 homes, several schools and churches, a correctional facility and other commercial and government buildings were within a one-mile evacuation radius of the facility, though late Thursday was reduced to 1/8 mile, a radius inside which there are no homes, local news [reported](#). Wake Forest University, which sits just outside the evacuation zone, cancelled classes, urging students in dorms to stay indoors and close their windows.

Due to its unpredictable nature, firefighters still can't get within 300ft of the blaze, according to official [statements](#).

[Read More](#)

The Guardian, 5 February 2022

<https://www.theguardian.com/us-news/2022/feb/04/north-carolina-fertilizer-plant-fire-explosion-evacuation>

Date set for first youth-led climate trial in U.S. history

2022-02-08

For the first time in U.S. history, a youth-led climate change lawsuit will go to trial.

In [Held v. State of Montana](#), 16 youth plaintiffs have sued the state over its energy policy, alleging that its heavy dependence on fossil fuel development accelerates climate change and infringes on their constitutional right to a clean and healthful environment. The trial will start Feb. 6, 2023, according to documents obtained by NBC News.

About 6,500 under evacuation orders while firefighters still can't get within 300ft of blaze at North Carolina plant

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The complaint was filed in March 2020. In August 2021, a judge denied the state's move to dismiss it, allowing it to move to trial — the first lawsuit of its kind in the United States.

"Children are uniquely vulnerable to the consequences of the climate crisis, which harms Youth Plaintiffs' physical and psychological health and safety, interferes with family and cultural foundations and integrity, and causes economic deprivations," the complaint states.

Montana is one of six states that mention environmental rights in its state constitution. Article IX, added in 1972, reads: "The state and each person shall maintain and improve a clean and healthful environment in Montana for present and future generations."

Globally, lawsuits around climate change are becoming more frequent. A database kept by the Sabin Center for Climate Change Law at Columbia Law School now includes case documents for more than 1,000 climate change lawsuits from around the world.

A federal judge in Australia ruled last May that the government had a "duty of care" for young people when making decisions involving climate change. But the group of teenage climate change activists lost its fight against the expansion of a coal mine.

[Read More](#)

NBC News, 8 February 2022

<https://www.nbcnews.com/science/environment/date-set-first-youth-led-climate-trial-us-history-rcna11793>

Toxic air pollutants targeted in proposed bill from Colorado Democrats

2022-02-15

Legislation would enact health-based emissions limits for polluters like Suncor.

A coalition of Colorado environmental and community groups on Monday unveiled the next step in a years-long effort to close what they say are gaps in federal regulation that have left low-income communities and people of color especially vulnerable to toxic air pollution.

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Legislation set to be introduced by Democrats in the Colorado General Assembly this week will address so-called air toxics emitted by industrial pollution sources like the Suncor oil refinery in Commerce City, following up on previous legislation passed by lawmakers in 2020 and 2021.

"Communities of color and low-income communities that have disproportionately faced the impacts (of pollution) deserve better," Lizeth Chacon, executive director of the Colorado People's Alliance, said in a statement. "We need to work to ensure that we are prioritizing our health and safety and not the bottom line of corporations."

Activists and lawmakers spoke at the state Capitol on Monday in support of a bill that sponsor Rep. Serena Gonzales-Gutierrez, a Democrat from Denver, said would help create a "safe and healthy environment" for all Coloradans.

"I can't tell you how many young people have had to miss school because of their issues with asthma and inability to just walk to school because of the air," Gonzales-Gutierrez said. "Study after study has shown ... that toxic pollution systemically and disproportionately harms people of color."

House Bill 21-1189, passed by state legislators last year, required polluters like Suncor to conduct real-time, "fenceline" emissions monitoring and establish emergency notification systems to alert nearby communities of potentially hazardous incidents. The new legislation would go further, directing regulators at the Colorado Department of Public Health and Environment to set health-based emissions limits and enact rules to enforce them.

[Read More](#)

Colorado News Line, 15 February 2022

<https://coloradonewsline.com/2022/02/15/toxic-air-pollutants-bill-colorado-democrats/>

New Air Pollutant Listings Bring 'Domino Effect' to Industry

2022-02-14

Federal focus on a chemical in degreasing and dry-cleaning products has attorneys keeping a close eye out for more air toxics scrutiny from the EPA—and wondering when it will ever come.

Legislation would enact health-based emissions limits for polluters like Suncor.

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The Environmental Protection Agency added 1-bromopropane to its list of Hazardous Air Pollutants, or HAPs, last month, the first chemical the agency has added since the list was created in 1990.

The add has a “domino effect” of regulatory implications for industry already operating under HAP standards, according to Holland & Hart LLP partner Emily Schilling.

“You may be subject to specific standards for 1-BP in the future, but the fact that you emit right now could have substantial regulatory impacts for you starting immediately,” she said.

The move is also the start of other chemical standards to come—a “grand trend” in environmental law along with climate change and environmental justice, King & Spalding LLP partner Doug Henderson told Bloomberg Law.

“It’s really a signal for the next 20 years, there will be intense focus on all chemicals and substances, where there has not been either any analysis or the analysis may be 30 or 40 years old to see how toxic a substance may be,” he said.

Interim Preparation

The EPA lists new HAPs after years-long risk evaluations that determine certain concentrations “are known to cause or may reasonably be anticipated to cause adverse effects to human health or the environment.”

Now that 1-BP is on the roster of more than 180 chemicals, the EPA still needs to propose and finalize regulations—another lengthy process. EPA plans to issue a “regulatory infrastructure” on what compliance will look like for new chemical additions, which will likely be finalized in 2023.

Adding to the toxics list dredges up multiple considerations for industry, despite the long slog and regulatory uncertainty that comes with it.

Federal scrutiny can spur focus on how to implement new replacement chemicals to offset risk, or how to better incorporate environmental, social and corporate governance concerns, according to Henderson.

To prepare in the meantime, companies emitting 1-BP should assess their emissions potentials and get a handle on how they could affect their compliance, according to Hunton Andrews Kurth LLP partner Matt Leopold, who served as EPA general counsel during the Trump administration.

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“You should consider, if you’re not already a major source, whether or not those 1-BP emissions would put you over the threshold into becoming a major source,” he said.

Read More

Bloomberg Law, 14 February 2022

<https://news.bloomberglaw.com/environment-and-energy/new-air-pollutant-listings-bringing-domino-effect-to-industry>

EUROPE

EU proposals on pollutant regulations could cost Northern Ireland millions in waste collection

2022-02-15

Proposals by the European Union to strengthen their internal rules on pollutants could hit the public purse in Northern Ireland and change the way some waste streams are dealt with in the region, according to new analysis by the Commons European scrutiny committee.

If introduced, the EU plans will see some construction waste in NI diverted from landfill to incinerators in Great Britain and collections for ash from domestic wood and coal burning potentially separated – which could cost more than £1m annually.

Dealing with household ash would also incur an additional estimated one-off cost of £5.4m.

The EU plans target Persistent Organic Pollutants – substances that remain intact in the environment over long periods and are harmful to the environment, wildlife and human health. A recent study, for example, identified high levels of some of these substances in otters in England and Wales

The plans will make current controls in the EU and Northern Ireland more stringent than in Great Britain and add to the list of restricted chemicals in waste.

Under the terms of the Northern Ireland Protocol, Northern Ireland must follow the European regulations on chemical waste.

Proposals by the European Union to strengthen their internal rules on pollutants could hit the public purse in Northern Ireland

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Persistent Organic Pollutants are particularly dangerous because they increase in concentration as they travel up the food chain and with the passage of time. Fortunately, many are no longer used in new products but still appear in waste.

Chemical regulations are part of a raft of retained EU laws – laws transposed into UK law to avoid a post-Brexit legal cliff-edge – which are treated differently in courts to UK-made laws.

Retained EU law, what it is and whether it is fit for purpose, is also currently the subject of an [inquiry](#) by the European Scrutiny committee.

[Read More](#)

Politics.co.uk, 15 February 2022

<https://www.politics.co.uk/news-in-brief/eu-proposals-on-pollutant-regulations-could-cost-northern-ireland-millions-in-waste-collection/>

France: Destruction of unsold non-food items prohibited

2022-02-08

From January 1st 2022, unsold non-food items can no longer be destroyed by incineration. The objective for 2022 is to reuse or recycle unsold non-food products and therefore prevent a large part of the millions of unsold non-food items from being destroyed and causing more greenhouse gas emissions.

The particular products concerned by the application of this provision provided for by [the law on the fight against waste](#) and [the circular economy \(Law AGECE\)](#) are:

- Textiles (clothing, shoes, etc.).
- Ink cartridges.
- Hygiene and childcare products.
- Food storage and cooking equipment.
- Leisure products.
- Books and school supplies.
- Electrical and electronic products.

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Note: Some of these products, which do not yet benefit from an extended producer responsibility (EPR) recycling channel, have until December 31st 2023 to comply. From December 31, 2023, all products will be affected.

More sources of recent information about the guidance surrounding other goods and the circular economy can be found below:

- [Single-use plastic products: Cotton swabs, cups, fruit and vegetable packaging...: what disposable plastic products are prohibited?](#)
- [Repairability index: something new in the fight against waste](#)
- [End of plastic packaging for fruit and vegetables: what timetable?](#)

For more information about the Changes effective January 1st 2022, consult the Ministry of Ecological Transition website [here](#).

[Read More](#)

Eurofins, 8 February 2022

<https://www.eurofins.com/consumer-product-testing/media-centre/news/regulatory-updates-02-2022/>

Factual Summary Report of the Public Consultation on the EU Strategy for Sustainable Textiles

2022-02-18

This report provides a factual summary of the results of the Online Public Consultation (OPC) held in the context of the preparation of the upcoming EU Strategy for Sustainable Textiles [1](#). The OPC was one element of a wider consultation that also included a set of seven workshops as well as consultation with national authorities. A more in-depth analysis of the consultation activities will feed into the final report in support of the preparation of the EU Strategy for Sustainable Textiles.

The OPC took place between 12.05.2021 and 04.08.2021. It was launched on the EU Better Regulation platform, Have Your Say, and targeted all citizens and organisations. It was advertised via the European Circular Economy Stakeholder Platform [2](#) and through the social media accounts of the Directorate General for the Environment and Directorate General for Internal Market, Industry, Entrepreneurship and SMEs.

This report provides a factual summary of the results of the Online Public Consultation (OPC) held in the context of the preparation of the upcoming EU Strategy for Sustainable Textiles

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This document should be regarded solely as a summary of the contributions made by stakeholders to the online public consultation on the EU Strategy for Sustainable Textiles. It cannot in any circumstances be regarded as the official position of the Commission or its services. Responses to the consultation activities cannot be considered as representative sample of the views of the EU population.

[Read More](#)

Eur-lex, 18 February 2022

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=PI_COM%3AAres%282022%29771808

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REACH Update

FEB. 25, 2022

ECHA public consultation: call for comments

2022-02-17

Deadline: 8 April 2022

The Great Britain Mandatory Classification and Labelling (GB MCL) process includes the consideration of information gathered from public consultations, conducted by HSE or international bodies such as the European Chemicals Agency (ECHA).

ECHA has announced a public consultation on the following proposals for harmonised classification and labelling (CLH):

- dibenzoyl peroxide; benzoyl peroxide (EC: 202-327-6; 94-36-0). Chemical registered under REACH
- reaction mass of 1,3-dioxan-5-ol and 1,3-dioxolan-4-ylmethanol (EC: -; -). Chemical registered under REACH

[View the details.](#)

UK-based businesses with an interest in the proposals are strongly encouraged to share any relevant information.

Scientific and technical information should be submitted directly to ECHA using their commenting webform by **8 April 2022**. Comments will be published on ECHA's website.

If your business is affected by the GB CLP Regulation, please also consider if you are likely to be affected by the classification and labelling proposal and let us know at an early stage if you anticipate any significant impacts or benefits.

Information on wider policy and impact considerations can be submitted to HSE at GBCLP.GBMCL@hse.gov.uk.

Under the GB CLP Regulation, HSE will consider all published opinions of the Committee of Risk Assessment of ECHA (RAC) before publishing its own Agency Technical Reports and Agency Opinions, so any information you provide will be important in any final GB MCL decision.

Scientific and technical information should be submitted directly to ECHA using their commenting webform by 8 April 2022.

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More information on the new [GB MCL system](#) is available on the HSE website.

ECHA, 17 February 2022

<https://echa.europa.eu/harmonised-classification-and-labelling-consultation>

ECHA Recommends Restricting the Use of Lead in the European Union

2022-02-14

The European Chemicals Agency (ECHA) published a [draft recommendation](#) on Feb. 2 for the inclusion of Lead in Annex XIV ("The Authorization List") under the European Union's (EU) Registration, Evaluation, Authorization and Restrictions of Chemicals (REACH) regulation.

If the EU Commission decides to include lead on the Authorization List, manufacturers, importers and downstream users will be prohibited from placing this substance on the EU market unless that entity has an exemption or is authorized for its use under REACH rules.

[The EU REACH regulation](#) attempts to protect human health and the environment from the risks posed by hazardous chemical substances. The regulation establishes procedures for collecting, assessing and managing the introduction and use of chemical substances in the European market.

One of these regulatory tools is known as Annex XIV; the Authorization List. Under the Authorization procedure, ECHA can submit recommendations to take currently listed Substances of Very High Concern (SVHC) and add them to Annex XIV. Once the EU Commission places the SVHC in Annex XIV, the listed substance can no longer be introduced into the EU market, unless specific businesses and manufacturing entities apply for authorizations for certain uses.

It is important to note that these restrictions are only applicable to manufacturing and processing entities operating in the EU. When an importer or manufacturer introduces these substances in their articles outside of the European marketplace, REACH does not apply. Therefore, SVHCs may still be imported into the EU without meeting the authorization requirements of REACH.

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REACH Update

FEB. 25, 2022

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AEM, 14 February 2022

<https://www.aem.org/news/echa-recommends-restricting-the-use-of-lead-in-the-european-union>

If the EU Commission decides to include lead on the Authorization List, manufacturers, importers and downstream users will be prohibited from placing this substance on the EU market.

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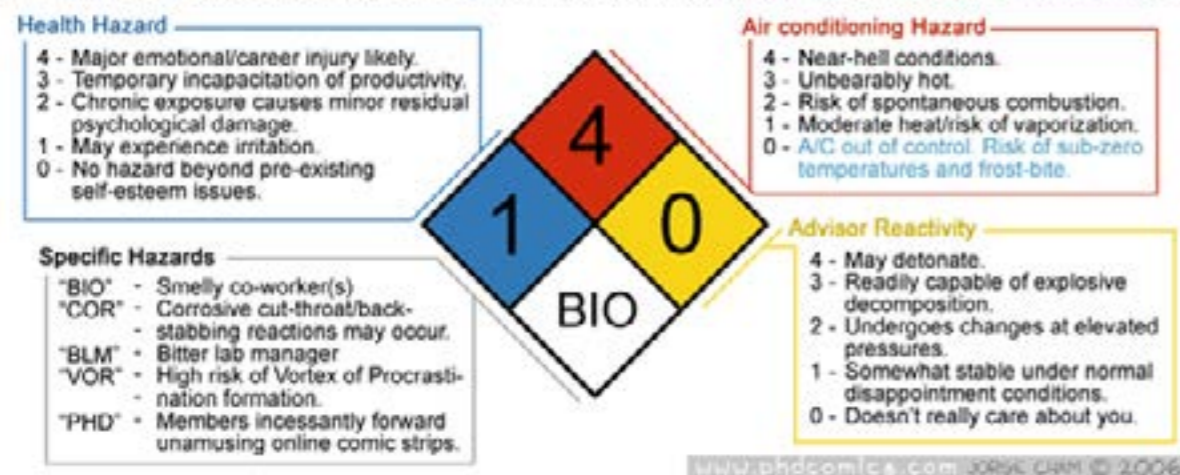
Janet's Corner

FEB. 25, 2022

Lab Hazard Rating System

2022-02-25

LAB HAZARD RATING SYSTEM Post this rating system to allow visitors and potential members to quickly and easily identify risks posed by exposure or prolonged contact to a particular research group.



<https://phdcomics.com/comics/archive.php?comid=738>

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Hazard Alert

FEB. 25, 2022

Caesium

2022-02-25

Caesium is a chemical element with symbol Cs and atomic number 55. [1] It is silvery gold, soft, and ductile. It is the most electropositive and most alkaline element. Caesium, gallium, and mercury are the only three metals that are liquid at or around room temperature. Caesium reacts explosively with cold water and reacts with ice at temperatures above -116°C. Caesium hydroxide is a strong base and attacks glass. Caesium reacts with the halogens to form a fluoride, chloride, bromide, and iodide. Caesium metal oxidises rapidly when exposed to the air and can form the dangerous superoxide on its surface. [2] Caesium is a naturally-occurring element found in rocks, soil, and dust at low concentrations. Natural caesium is present in the environment in only one stable form, as the isotope ¹³³Cs. [3]

USES [2]

Caesium is used in industry as a catalyst promoter, boosting the performance of other metal oxides in the capacity and for the hydrogenation of organic compounds. Caesium nitrate is used to make optical glasses. Caesium is sometimes used to remove traces of oxygen from the vacuum tubes and from light bulbs. Caesium salts are used to strengthen various types of glass. The chloride is used in photoelectric cells, in optical instruments, and in increasing the sensitivity of electron tubes. Caesium is used in atomic clocks and more recently in ion propulsion systems.

SOURCES & ROUTES OF EXPOSURE [3,4]

Sources of Exposure

- You can be exposed to low levels of stable or radioactive caesium by breathing air, drinking water, or eating food containing caesium.
- Food and drinking water are the largest sources of exposure to caesium.
- You can be exposed to radioactive caesium if you eat food that was grown in contaminated soil, or if you come near a source of radioactive caesium.
- Working in industries that process or use natural caesium or caesium compounds.
- Living near uncontrolled radioactive waste sites containing caesium.

Caesium is a chemical element with symbol Cs and atomic number 55.

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Routes of Exposure

Stable and radioactive caesium can enter your body from the food you eat or the water you drink, from the air you breathe, or from contact with your skin. When you eat, drink, breathe, or touch things containing caesium compounds that can easily be dissolved in water, caesium enters your blood and is carried to all parts of your body. Caesium is like potassium; it enters cells and helps to maintain a balance of electrical charges between the inside and the outside of cells so that cells can perform tasks that depend on those electrical charges. Cells like muscle cells and nerve cells require changing electrical charges in order to function properly and allow you to think and move. Once caesium enters your body, your kidneys begin to remove it from the blood; some caesium is quickly released from your body in the urine. A small portion is also released in the faeces. Some of the caesium that your body absorbs can remain in your body for weeks or months but is slowly eliminated from your body through the urine and faeces.

HEALTH EFFECTS [4]

Effects of Caesium

It is highly unlikely that you would be exposed to high enough amounts of stable caesium to cause harmful health effects. Laboratory animals given very large amounts of caesium compounds showed changes in behaviour, such as increased or decreased activity. Exposure to large amounts of radioactive caesium can damage cells in your body from the radiation. You might also experience acute radiation syndrome, which includes nausea, vomiting, diarrhoea, bleeding, coma, and even death in cases of very high exposures.

Carcinogenicity

There are no studies regarding non-radioactive caesium and cancer. There are no human studies that specifically associate exposure to radioactive caesium with increased cancer risk. Because radioactive caesium emits ionising radiation, carcinogenic effects similar to those observed in Japanese survivors of the atomic bombing incidents might be expected among individuals acutely exposed to very high levels of radiation from a radioactive caesium source. Rats exposed to high doses of radiation from ^{137}Cs had increased risk of mammary tumours. Older rats seemed more resistant than younger ones.

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SAFETY [5]

First Aid Measures

- Eyes: Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately.
- Skin: Get medical aid immediately. Flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes.
- Ingestion: If victim is conscious and alert, give 2-4 cupfuls of milk or water. Get medical aid immediately.
- Inhalation: Get medical aid immediately. Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.
- Notes to Physician: Treat symptomatically.

Fires & Explosion Information

- As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear.
- Caesium can burn in a fire, releasing toxic vapours.
- Caesium will react with water and may release a flammable and/or toxic gas.
- May ignite or explode on contact with steam or moist air.
- Do NOT use water directly on fire.

Exposure Controls & Personal Protection

Engineering Controls

- Use explosion-proof ventilation equipment.
- Use process enclosure, local exhaust ventilation, or other engineering controls to control airborne levels.

Personal Protective Equipment

The following personal protective equipment is recommended when handling caesium:

- Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

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- Skin: Wear appropriate protective gloves and clothing to prevent skin exposure.
- Clothing: Wear appropriate protective clothing to minimize contact with skin.
- Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Always use a NIOSH or European Standard EN 149 approved respirator when necessary.

REGULATION

United States [3]

There are few guidelines for compounds of stable caesium.

- NIOSH: Based on eye irritation, the National Institute for Occupational Safety & Health has established a recommended exposure limit (REL) for caesium hydroxide of 2 mg/m³ as a time-weighted average (TWA) for up to a 10-hour workday and a 40-hour workweek.
- ACGIH: The American Conference of Governmental Industrial Hygienists has assigned caesium hydroxide a threshold limit value (TLV) of 2 mg/m³ as a TWA for a normal 8-hour workday and a 40-hour workweek, based on respiratory and eye irritation.
- NRC: The Nuclear Regulatory Commission has established guidelines for radioactive caesium that include occupational inhalation exposure Derived Air Concentrations (DACs) of 0.00000004 iCi/mL (4x10⁻⁸ iCi/mL) for 134Cs and 0.00000006 iCi/mL (6x10⁻⁸ iCi/mL) for 137Cs. Annual Limits on Intake (ALIs) for on-the-job exposure are 100 iCi (1x10² iCi) for 134Cs and 200 iCi (2x10² iCi) for 137Cs.

Australia [6]

Safe Work Australia: Safe Work Australia has established an 8-hour time-weighted average concentration for caesium of 2mg/m³.

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2. <http://www.lenntech.com/periodic/elements/cs>
3. <http://www.atsdr.cdc.gov/phs/phs.asp?id=575&tid=107>
4. <http://www.atsdr.cdc.gov/tfacts157.pdf>
5. <http://www.sciencelab.com/msds.php?msdsId=13280>

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6. <http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/772/Workplace-exposure-standards-airborne-contaminants.pdf>

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Gossip

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Europe proposes drastic cuts of BPA, a hormone disruptor found in plastics and food

2022-02-16

In a move that could signal a new approach to regulating potentially hazardous compounds, European health experts are recommending a drastic cut in the allowable human consumption of a common chemical in food. The European Food Safety Authority (EFSA) has proposed reducing by a factor of 100,000 the tolerable daily intake of bisphenol A (BPA), an endocrine disruptor that interferes with hormone systems and has been linked to disease.

The huge reduction could lead to a de facto ban on the cheap and durable material in food-related uses, such as lining metal cans. And it could mark a shift in how European regulators use research findings in setting exposure limits. Traditionally, those limits have been shaped by large studies directly linking a chemical to an increased risk of disease. In this case, however, risk assessors put greater weight on smaller studies showing low levels of BPA can cause subtle changes that could lead to future health problems. This approach, if adopted widely, could justify much lower exposure limits for other chemicals.

"It's a big deal," says Laura Vandenberg, an endocrinologist at the University of Massachusetts, Amherst, who calls the proposed limit "a gravestone for BPA in Europe." Environmental and public health advocates are praising the proposal, which is open for comment until 22 February.

Industry groups, however, are dismayed. Plastics Europe argues EFSA ignored relevant, older studies in setting the standard. "If the entire scientific evidence had been evaluated ... we are convinced that the conclusions would have been different," says Jasmin Bird, a spokesperson for the group. Jennifer Garfinkel, a spokesperson for the industry-backed American Chemistry Council, calls EFSA's proposal "unprecedented," noting that the U.S. Food and Drug Administration (FDA) has concluded that BPA is safe at current exposures.

Bisphenol A is used in many plastics, including thermal paper for receipts, but most people are exposed through food. BPA leaches out of polycarbonates used to make bottles and food containers, for example, as well as the epoxy liners used to protect steel and aluminum cans from acidic food and beverages.

In 2014, after reviewing recent studies, an expert panel assembled by EFSA recommended temporarily lowering the tolerable daily intake from 50 to 4

BPA leaches out of polycarbonates used to make bottles and food containers, for example, as well as the epoxy liners used to protect steel and aluminum cans from acidic food and beverages.

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micrograms per kilogram of body weight per day. The panel was especially intrigued by studies suggesting BPA altered the immune systems of rats. Before making a firmer recommendation, however, the EFSA panel wanted to see the results of a \$30 million research program funded by the U.S. government.

This program, which ran from 2014 to 2018, compared academic research studies with a large study of rats exposed to BPA—the kind of standardized animal study that industry and FDA typically rely on to assess health risks. The rat study supported FDA's recommended daily limit of 5 micrograms. But the academic studies, which included analyses of how low doses affected mammary glands in lab animals, produced results that EFSA experts considered worrisome.

To set an intake limit, the EFSA panel looked at the study in which the lowest dose produced a biological effect. That research, conducted at Anhui Medical University in China, showed that as BPA exposure rose in mice, so did the numbers of immune cells that are key players in inflammatory and autoimmune diseases. Based on that finding, the panel recommended cutting the BPA limit 100,000-fold, to 0.04 nanograms.

Although EFSA says it did not change its basic approach in re-evaluating BPA, scientists say risk assessors are giving increasing weight to smaller research studies that agency experts have traditionally discounted. "It's a tremendous change," says Ángel Nadal, a physiologist at the Miguel Hernández University of Elche. EFSA unveiled its analysis and proposed limit in December 2021. BPA exposure was "a health concern ... for all age groups," the expert panel wrote. And it noted that most people consume far more BPA than allowed under the proposed limit.

EFSA is now pushing to finalize the new standard by December. EU legislators would then use it to establish legally binding limits on how much BPA is allowed to leach from packaging into food.

"If we are logical, there should be some action very quickly on BPA," says Robert Barouki, a toxicologist at the University of Paris.

In the United States, a number of groups recently urged FDA to follow EFSA's lead and consider new limits on BPA. Others note that people are often exposed to BPA in combination with other chemicals, which could increase the risk from low doses. For example, children of Swedish women exposed to BPA and other endocrine disruptors early in pregnancy have a higher risk of language delays, according to a study in *Science* this

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week. "This is another argument for reducing BPA," says co-author Barbara Demeneix, an endocrinologist with the Natural History Museum in Paris.

Even if Europe adopts the new standard, public health advocates worry manufacturers will replace BPA with very similar chemicals, such as bisphenol S (BPS), that have also been linked to health effects. "We don't want to see this assessment repeated for the BPS or BPF [bisphenol F] and need more decades of risk assessment," says Ninja Reineke, head of science at the CHEM Trust, an advocacy group that focuses on environmental and health impacts of endocrine disruptors.

To avoid that problem, many advocates have called for regulators around the world to set limits for whole classes of related compounds, rather than consider them one by one. For now, Vandenberg says, regulators are simply playing "chemical whack-a-mole."

AAAS, 16 February 2022

<https://science.org>

Sunlight helps clean up oil spills in the ocean more than previously thought

2022-02-16

Sunlight may have helped remove as much as 17 percent of the oil slicking the surface of the Gulf of Mexico following the 2010 Deepwater Horizon spill. That means that sunlight plays a bigger role in cleaning up such spills than previously thought, researchers suggest February 16 in Science Advances.

When sunlight shines on spilled oil in the sea, it can kick off a chain of chemical reactions, transforming the oil into new compounds. Some of these reactions can increase how easily the oil dissolves in water, called photodissolution. But there has been little data on how much of the oil becomes water-soluble.

To assess this, environmental chemists Danielle Haas Freeman and Collin Ward, both of Woods Hole Oceanographic Institution in Massachusetts, placed samples of the Macondo oil from the Deepwater Horizon spill on glass disks and irradiated them with light using LEDs that emit wavelengths found in sunlight. The duo then chemically analyzed the irradiated oil to see how much was transformed into dissolved organic carbon.

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The most important factors in photodissolution, the researchers found, were the thickness of the slick and the wavelengths of light. Longer wavelengths (toward the red end of the spectrum) dissolved less oil, possibly because they are more easily scattered by water, than shorter wavelengths. How long the oil was exposed to light was not as important.

Though the team didn't specifically test for seasonal or latitude differences, computer simulations based on the lab data suggested that those factors, as well as the oil's chemical makeup, also matter.

The researchers estimate irradiation helped dissolve from 3 to 17 percent of surface oil from the Deepwater Horizon spill, comparable to processes such as evaporation and stranding on coastlines. What impact the sunlight-produced compounds might have on marine ecosystems, however, isn't yet known.

Science News, 16 February 2022

<https://sciencenews.org>

New planet detected around Proxima Centauri, closest star our solar system

2022-02-10

A team of astronomers using the European Southern Observatory's Very Large Telescope (ESO's VLT) in Chile have found evidence of another planet orbiting Proxima Centauri, the closest star to our Solar System. This candidate planet is the third detected in the system and the lightest yet discovered orbiting this star. At just a quarter of Earth's mass, the planet is also one of the lightest exoplanets ever found.

"The discovery shows that our closest stellar neighbour seems to be packed with interesting new worlds, within reach of further study and future exploration," explains João Faria, a researcher at the Instituto de Astrofísica e Ciências do Espaço, Portugal and lead author of the study published today in *Astronomy & Astrophysics*. Proxima Centauri is the closest star to the Sun, lying just over four light-years away.

The newly discovered planet, named Proxima d, orbits Proxima Centauri at a distance of about four million kilometres, less than a tenth of Mercury's distance from the Sun. It orbits between the star and the habitable zone -- the area around a star where liquid water can exist at the surface of a planet -- and takes just five days to complete one orbit around Proxima Centauri.

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The star is already known to host two other planets: Proxima b, a planet with a mass comparable to that of Earth that orbits the star every 11 days and is within the habitable zone, and candidate Proxima c, which is on a longer five-year orbit around the star.

Proxima b was discovered a few years ago using the HARPS instrument on ESO's 3.6-metre telescope. The discovery was confirmed in 2020 when scientists observed the Proxima system with a new instrument on ESO's VLT that had greater precision, the Echelle SPectrograph for Rocky Exoplanets and Stable Spectroscopic Observations (ESPRESSO). It was during these more recent VLT observations that astronomers spotted the first hints of a signal corresponding to an object with a five-day orbit. As the signal was so weak, the team had to conduct follow-up observations with ESPRESSO to confirm that it was due to a planet, and not simply a result of changes in the star itself.

"After obtaining new observations, we were able to confirm this signal as a new planet candidate," Faria says. "I was excited by the challenge of detecting such a small signal and, by doing so, discovering an exoplanet so close to Earth."

At just a quarter of the mass of Earth, Proxima d is the lightest exoplanet ever measured using the radial velocity technique, surpassing a planet recently discovered in the L 98-59 planetary system. The technique works by picking up tiny wobbles in the motion of a star created by an orbiting planet's gravitational pull. The effect of Proxima d's gravity is so small that it only causes Proxima Centauri to move back and forth at around 40 centimetres per second (1.44 kilometres per hour).

"This achievement is extremely important," says Pedro Figueira, ESPRESSO instrument scientist at ESO in Chile. "It shows that the radial velocity technique has the potential to unveil a population of light planets, like our own, that are expected to be the most abundant in our galaxy and that can potentially host life as we know it."

"This result clearly shows what ESPRESSO is capable of and makes me wonder about what it will be able to find in the future," Faria adds.

ESPRESSO's search for other worlds will be complemented by ESO's Extremely Large Telescope (ELT), currently under construction in the

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Atacama Desert, which will be crucial to discovering and studying many more planets around nearby stars.

Science Daily, 10 February 2022

<https://sciencedaily.com>

CROPSR: A new tool to accelerate genetic discoveries

2022-02-17

Commercially viable biofuel crops are vital to reducing greenhouse gas emissions, and a new tool developed by the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI) should accelerate their development -- as well as genetic editing advances overall.

The genomes of crops are tailored by generations of breeding to optimize specific traits, and until recently breeders were limited to selection on naturally occurring diversity. CRISPR/Cas9 gene-editing technology can change this, but the software tools necessary for designing and evaluating CRISPR experiments have so far been based on the needs of editing in mammalian genomes, which don't share the same characteristics as complex crop genomes.

Enter CROPSR, the first open-source software tool for genome-wide design and evaluation of guide RNA (gRNA) sequences for CRISPR experiments, created by scientists at CABBI, a Department of Energy-funded Bioenergy Research Center (BRC). The genome-wide approach significantly shortens the time required to design a CRISPR experiment, reducing the challenge of working with crops and accelerating gRNA sequence design, evaluation, and validation, according to the study published in BMC Bioinformatics.

"CROPSR provides the scientific community with new methods and a new workflow for performing CRISPR/Cas9 knockout experiments," said CROPSR developer Hans Müller Paul, a molecular biologist and Ph.D. student with co-author Matthew Hudson, Professor of Crop Sciences at the University of Illinois Urbana-Champaign. "We hope that the new software will accelerate discovery and reduce the number of failed experiments."

To better meet the needs of crop geneticists, the team built software that lifts restrictions imposed by other packages on design and evaluation of gRNA sequences, the guides used to locate targeted genetic material. Team members also developed a new machine learning model that would not avoid guides for repetitive genomic regions often found in plants, a problem with existing tools. The CROPSR scoring model provided much more accurate predictions, even in non-crop genomes, the authors said.

The genome-wide approach significantly shortens the time required to design a CRISPR experiment, reducing the challenge of working with crops

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“The goal was to incorporate features to make life easier for the scientist,” Müller Paul said.

Many crops, particularly bioenergy feedstocks, have highly complex polyploid genomes, with multiple sets of chromosomes. And some gene-editing software tools based on diploid genomes (like those from humans) have trouble with the peculiarities of crop genomes.

“It can sometimes take weeks or months to realize that you don’t have the outcome that you expected,” Müller Paul said.

For example, a trait may be regulated by a collection of genes, particularly one involving plant stress where backup systems are useful. A scientist might design an experiment to knock out one gene and be unaware of another that performs the same function. The problem may not be discovered until the plant matures without altering the trait in any way. It’s a particular issue with crops that require specific weather conditions to grow, where missing a season could mean a year-long delay.

Using a genome-wide approach allowed the scientists to tailor CROPSR for plant use by removing built-in biases found in existing software tools. Because they are based on human or mouse genomes, where multiple copies of genes are less common, those tools penalize gRNA sequences that hit the genome in more than one position, to avoid causing mutations in places where they’re not intended. But with crops, the goal is often to mutate more than one position to knock out all copies of a gene. Previously, scientists sometimes had to design four or five mutation experiments to knock out each gene individually, requiring extra time and effort.

CROPSR can generate a database of usable CRISPR guide RNAs for an entire crop genome. That process is computationally intensive and time-consuming -- usually requiring several days -- but researchers only have to do it once to build a database that can then be used for ongoing experiments.

So, rather than searching for a targeted gene through an online database, then using current tools to design separate guides for five different locations and doing multiple rounds of experiments, scientists could search for the gene in their own database and see all the guides available. CROPSR would indicate other locations to target in the genome as well. Researchers could select a guide that hits all of the genes, making it much easier and quicker to design the experiment.

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“You can just hop into the database, fetch all the information you need, ready to go, and start working,” Müller Paul said. “The less time you spend planning for your experiments, the more time you can spend doing your experiments.”

For CABBI scientists, who often work with repetitive plant genomes, having a gRNA tool that allows them to design functioning guides with confidence “should be a step forward,” he said.

As the name implies, CROPSR was designed with crop genomes in mind, but it’s applicable to any type of genome.

“CROPSR is also based on human genes, as the data availability for crop genes just isn’t there yet,” Müller Paul said, “but we’re looking into some collaborations with other BRCs to provide a more capable prediction based on biophysics to help mitigate some of the issues caused by the lack of data.”

Going forward, he hopes researchers will record their failed results along with successes to help generate the data to train a crop-specific model. If the collaborations pan out, “we could be looking at some very interesting advancements in training machine learning models for CRISPR applications, and potentially to other models as well.”

The study’s other co-authors are Dave Istanto, former CABBI graduate student with Hudson in the U of I Department of Crop Sciences; and Jacob Heldenbrand, former CABBI research programmer with the National Center for Supercomputing Applications at Illinois. Hudson and Müller Paul are also affiliated with the Illinois Informatics Institute and the Carle R. Woese Institute for Genomic Biology.

Science Daily, 17 February 2022

<https://sciencedaily.com>

Sounds of a healthy ocean can bring degraded marine ecosystems back to life

2022-02-05

A healthy marine ecosystem is an orchestra of sounds — the rhythmic humming of fish calling to each other, crabs scuttling along reefs and sea grass rustling in the currents. But when an ecosystem is dying, not much life is there to make sounds.

“Sound travels very far underwater without being lost to things like currents, making it a long-distance cue”

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Marine animals don't tend to flock to these wastelands. So when an ecosystem is degraded by human interference, storms or heat waves, it has a harder time coming back to life. If marine animals think there's life in these faltering environments, however, they are more likely to check them out and even put down roots.

Mounting research shows that the sounds of a healthy ocean habitat may be a pivotal tool in bringing unhealthy marine ecosystems back to life. Numerous research teams studying soundscape diversity in the ocean over the past few decades have found this to be the case. Just like how big cities draw more people, a bustling part of the ocean seems to draw more marine life. If marine animals hear a healthy-sounding environment, they're inclined to move in — even if the habitat has been destroyed.

What happened off Lizard Island in the Great Barrier Reef is an example.

A group of marine biologists studying ocean soundscapes regularly visited it because it's a protected area that was once teeming with life. But in 2016, weeks of a heat wave led to an enormous coral bleaching event that wiped out much of the reef. After the event, sounds of the reef had diminished significantly, says Steve Simpson, professor of marine biology and global change at the University of Bristol. That quiet matched the desolate ghost town the reefs had become.

"When you swam around, it looked like a black and white movie with the odd painted fish [standing out with] its bright colors, because it used to be camouflaged in a world of color," Simpson says.

Simpson's team decided to see whether they could lure larval fish back to the almost barren reefs off Lizard Island using old sound records of the marine habitat back when it was full of life. They also built up some of the broken reefs into piles to create more shelter for the fish. Sure enough, twice as many fish took up residence near speakers playing the old soundscape recordings than the areas of the reef that had no acoustic enhancement.

"If we did that on a bigger scale, we started to think, well, maybe sound could be a tool that we use to actually accelerate recovery," Simpson says.

Sound is a vital part of marine animals' ability to navigate and survive in their environment. In the early stages of life, they use sound to determine which habitat is the best place to call home.

"Sound travels very far underwater without being lost to things like currents, making it a long-distance cue," says Brittany Williams, a researcher

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at the University of Adelaide's Southern Seas Ecology Lab in Australia. It's much more useful than sight since water often obscures anything at a distance, as researchers such as Simpson quickly learned while traversing the Great Barrier Reef.

A marine ecosystem's health can be assessed by its soundscape diversity, or how complex and productive it is.

"Soundscape diversity can be thought of as the phonic richness of an environment, or the number and loudness of biotic sounds," says David Eggleston, director of the Center for Marine Sciences and Technology at North Carolina State University. Eggleston contributed to soundscape studies that demonstrate how oyster larvae are drawn to acoustically enhanced marine soundscapes, just as larval coral reef fish are.

Hydrophones are used to record marine soundscapes. Researchers then parse the soundscape diversity metrics within them.

"For example, we can calculate the number of snaps per minute in an ecosystem, to determine whether snapping shrimp crackle fills the ecosystem," Williams says.

Scientists haven't been closely listening to ocean soundscapes for long in retrospect, so researchers such as Williams are pioneers in the field. They have heard creatures that are rarely seen on diving expeditions. Some sounds are remarkable — one fish, Simpson recalls, sounded like a man laughing loudly across a bar. Other sounds are subtler, such as the rhythmic thumping that comes from an oyster toadfish's swim bladder.

When the underwater chatter in a previously declining environment grows more boisterous, it is a clear indicator of an ecosystem healing. So with improving underwater listening and recording technology, soundscape assessments will probably become integral to showing the complete picture of a restoration project's success. By listening to the soundscape, Simpson's team could tell that marine life had returned in spades to a reef off Indonesia that had been nearly destroyed by blast fishing, thanks to a prolific reef recovery project there.

As the catalogue of underwater sounds grows, scientists are even learning which sounds may help bolster the restoration efforts of a specific ecosystem. "We call it 'Reef DJ,' where we learn how to kind of mix the right track to get the recovery to happen in a particular place in the right way," Simpson says.

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But the process involves a lot of trial and error. Williams says using targeted sounds may attract some species while it repels others, or attract two conflicting species. "For example, a sound that attracts larval oysters will be no good if it also attracts predators that eat these larvae," she says.

Thanks to advancements in artificial intelligence, however, researchers are no longer alone in dissecting this growing soundscape catalogue. "We've got a team in London now developing artificial intelligence algorithms, machine-learning algorithms, to classify these sounds so that we can be listening to the ocean in real time," Simpson says.

He says there soon may be public systems that can broadcast these real-time records globally so that anyone can hear them.

This could be useful to restoration efforts that often rely on collaborations with scientists across specialties. It could even help scientists detect ocean habitats that are just beginning to decline so restoration efforts can be deployed before the ecosystems are in real trouble. And if more civilians connect with ocean soundscapes via these public broadcast systems, the struggling ecosystems may receive more support.

As climate change continues to trigger heat-fueled bleaching events and severe storms, reefs around the world will struggle to survive. But with the help of tools such as underwater soundscape enhancement and real-time listening and parsing technology, scientists can better protect and restore what remains.

"If we can actively maintain enough healthy coral reef environments around the world in places [where] they're least susceptible to either global or local threats, then that gives us the broodstock of the future, which will be able to repopulate areas that may lose reefs over the next few decades," Simpson says.

Washington Post, 5 February 2022

<https://washingtonpost.com>

A possible paradigm shift within piezoelectricity

2022-02-18

Piezoelectricity is used everywhere: Watches, cars, alarms, headphones, pickups for instruments, electric lighters and gas burners. One of the most common examples is probably the quartz watch, where the piezoelectric material quartz is a prerequisite for the watch's function.

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Piezoelectric materials have the particular property that their shape changes when applying an electrical voltage to the material. It also works the other way around: Exposing them to a mechanical impact will create an electrical voltage.

Piezoelectricity is often used in sensors, actuators, and resonators. In small devices, they are known as MEMS (micro-electromechanical systems). Here, materials other than quartz must be used. These materials, however, often contain lead in the form of lead zirconate titanate (PZT).

This may prove to be a barrier to the spread of technology in, for example, the biomedical field, as lead is harmful to the body. However, researchers assess an excellent potential for utilizing the piezoelectric effect in a wider range of diagnostics, prognosis and therapy technologies if lead could be removed.

In a new article in the journal *Science*, Professor Nini Pryds and Professor Vincenzo Esposito from DTU Energy show that it is possible to create piezoelectric effects in materials where this is not ordinarily possible. It paves the way for designing piezoelectric materials that are lead-free and far more environmentally friendly. The research was conducted with colleagues from EPFL (École Polytechnique Fédérale de Lausanne), Tel Aviv University and the University of Antwerp.

More environmentally friendly materials

The work stems from the DTU-coordinated EU project Biowings, where several European partners are researching the development of new biomedical MEMS made with thin, lead-free films based on Gadolinium-doped oxide materials that are non-toxic and environmentally friendly. It is a great challenge, but the potential within, e.g. blood cell sorting, bacterial separation, and estimation of hematocrit levels are high.

"Many micro-electromechanical systems already exist, but they often contain lead-containing materials that are harmful for human implantation. The BioWings project aims to develop biocompatible materials with properties similar to common lead-containing materials that do not contain lead or the other harmful materials," says Nini Pryds, adding:

"The new development will provide a fundamental step towards environmentally friendly piezoelectric materials with high performance for use, e.g. in car technology and medical applications," says Nini Pryds.

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As a fundamental premise, piezoelectric materials depend on crystal symmetry. Typical piezoelectric materials have a so-called non-centrosymmetric crystal lattice. This means, for example, that when one presses on the material, an electrical voltage naturally arises across the material due to the movement of positive and negative ions relative to each other. This results in the symmetry of the crystal being broken. For over a century, this has been a significant obstacle to finding new piezoelectric materials because piezoelectricity can only be created with a non-centrosymmetric crystal lattice.

Possible paradigm shift

One of the startling results of the new study is that a sizeable piezoelectric effect can be achieved with materials that do not usually allow it—i.e. centrosymmetric materials. Induction of piezoelectricity in centrosymmetric oxides can be achieved by using alternating current (AC) and direct current (DC) simultaneously. The field leads to the movement of positive and negative ion defects in the material relative to each other resulting in electric dipole or polarization. It breaks the crystal symmetry of the material, thereby achieving piezoelectricity in centrosymmetric crystals.

According to Nini Pryds, this concept will also be possible with other materials with similar atomic defects. It can thus help pave the way for non-lead-based piezoelectricity in, for example, actuators and sensors.

“For the time being, piezoelectric materials are limited to the non-centrosymmetric crystal structure. This entails a significant limitation in the number of materials that may be used. Our new results provide a paradigm shift towards inducing piezoelectricity in centrosymmetric crystals, thereby expanding the number of possible materials used. I expect it will have a significant effect on the design of new electromechanical devices with new biocompatible materials,” says Nini Pryds.

Phys Org, 18 February 2022

<https://phys.org>

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Study shows differences between brains of girls, boys with autism

2022-02-17

Brain organization differs between boys and girls with autism, according to a new study from the Stanford University School of Medicine.

The differences, identified by analyzing hundreds of brain scans with artificial intelligence techniques, were unique to autism and not found in typically developing boys and girls. The research helps explain why autism symptoms differ between the sexes and may pave the way for better diagnostics for girls, according to the scientists.

Autism is a developmental disorder with a spectrum of severity. Affected children have social and communication deficits, show restricted interests and display repetitive behaviors. The original description of autism, published in 1943 by Leo Kanner, MD, was biased toward male patients. The disorder is diagnosed in four times as many boys as girls, and most autism research has focused on males.

“When a condition is described in a biased way, the diagnostic methods are biased,” said the study’s lead author, Kaustubh Supekar, PhD, a clinical assistant professor of psychiatry and behavioral sciences. “This study suggests we need to think differently.”

The study was published online Feb. 15 in *The British Journal of Psychiatry*.

“We detected significant differences between the brains of boys and girls with autism, and obtained individualized predictions of clinical symptoms in girls,” said the study’s senior author, Vinod Menon, PhD, a professor of psychiatry and behavioral sciences and the Rachael L. and Walter F. Nichols, MD, Professor. “We know that camouflaging of symptoms is a major challenge in the diagnosis of autism in girls, resulting in diagnostic and treatment delays.”

Girls with autism generally have fewer overt repetitive behaviors than boys, which may contribute to diagnostic delays, the researchers said.

“Knowing that males and females don’t present the same way, both behaviorally and neurologically, is very compelling,” said Lawrence Fung, MD, PhD, assistant professor of psychiatry and behavioral sciences, who was not an author of the study.

Fung treats people with autism at Stanford Children’s Health, including girls and women with delayed diagnoses. Many autism treatments work

“When a condition is described in a biased way, the diagnostic methods are biased,” said the study’s lead author, Kaustubh Supekar, PhD

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best during the preschool years when the brain's motor and language centers are developing, he noted.

"If the treatments can be done at the right time, it makes a big, big difference: For instance, children on the autism spectrum receiving early language intervention will have a better chance of developing language like everyone else and won't have to keep playing catch-up as they grow up," Fung said. "If a child cannot articulate themselves well, they fall behind in many different areas. The consequences are really serious if they are not getting diagnoses early."

New statistical methods unlock differences

The study analyzed functional magnetic resonance imaging brain scans from 773 children with autism -- 637 boys and 136 girls. Amassing enough data to include a sizeable number of girls in the study was challenging, Supekar said, noting that the small number of girls historically included in autism research has been a barrier to learning more about them. The research team relied on data collected at Stanford and on public databases containing brain scans from research sites around the world.

The preponderance of boys in the brain-scan databases also set up a mathematical challenge: Standard statistical methods used to find differences between groups require that the groups be roughly equal in size. These methods, which underlie machine-learning techniques in which algorithms can be trained to find patterns in very large and complex datasets, can't accommodate a real-world situation in which one group is four times as large as the other.

"When I tried to identify differences [with traditional methods], the algorithm would tell me every brain is a male with autism," Supekar said. "It was over-learning and not distinguishing between males and females with autism."

Supekar discussed the problem with Tengyu Ma, PhD, assistant professor of computer science and of statistics at Stanford and a co-author on the study. Ma had recently developed a method that could reliably compare complex datasets, such as brain scans, from different-sized groups. The new technique provided the breakthrough the scientists needed.

"We happened to be lucky that this new statistical approach was developed at Stanford," Supekar said.

What differed?

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Using 678 of the brain scans from children with autism, the researchers developed an algorithm that could distinguish between boys and girls with 86% accuracy. When they verified the algorithm on the remaining 95 brain scans from children with autism, it maintained the same accuracy at distinguishing boys from girls.

The scientists also tested the algorithm on 976 brain scans from typically developing boys and girls. The algorithm could not distinguish among them, confirming that the sex differences the scientists found were unique to autism.

Among children with autism, girls had different patterns of connectivity than boys did in several brain centers, including motor, language and visuospatial attention systems. Differences in a group of motor areas -- including the primary motor cortex, supplementary motor area, parietal and lateral occipital cortex, and middle and superior temporal gyri -- were the largest between sexes. Among girls with autism, the differences in motor centers were linked to the severity of their motor symptoms, meaning girls whose brain patterns were most similar to boys with autism tended to have the most pronounced motor symptoms.

The researchers also identified language areas that differed between boys and girls with autism, and noted that prior studies have identified greater language impairments in boys.

"When you see that there are differences in regions of the brain that are related to clinical symptoms of autism, this seems more real," Supekar said.

Taken together, the findings should be used to guide future efforts to improve diagnosis and treatment for girls, the researchers said.

"Our research advances use of artificial intelligence-based techniques for precision psychiatry in autism," Menon said.

"We may need to have different tests for females compared with males. The artificial intelligence algorithms we developed may help to improve diagnosis of autism in girls," Supekar said. At the treatment level, interventions for girls could be initiated earlier, he added.

The study's other Stanford Medicine co-authors are scientific data analyst Carlo de los Angeles; senior research scientist Srikanth Ryali, PhD; and graduate student Kaidi Cao. Co-authors include members of Stanford's Maternal and Child Health Research Institute, Stanford Bio-X, the Stanford Wu Tsai Neurosciences Institute and the Stanford Wu Tsai Human

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Performance Alliance, and the Stanford Institute for Human-Centered Artificial Intelligence.

The research was supported by the National Institutes of Health (grants AG072114, MH084164 and MH221069), the Brain & Behavior Research Foundation, a Stanford Innovator Award and grants from the Stanford Maternal and Child Health Research Institutes, including the Transdisciplinary Initiatives Program, the Taube Maternal and Child Health Research Fund, and the Uytengsu-Hamilton 22q11 Neuropsychiatry Research Program.

Supekar is a Taube Family Endowed Transdisciplinary Investigator for Maternal and Child Health.

Science Daily, 17 February 2022

<https://sciencedaily.com>

Enhancing cross-cultural dialogues with AI

2022-02-10

A new project, led by Monash University researchers, will develop an Artificial Intelligence (AI)-assisted application to help with real-time interpretations for diplomatic talks, international business and tourism.

The US\$5 million project, funded by the US Department of Defense's Defense Advanced Research Projects Agency (DARPA), will develop a smart phone-based assistive dialogue system using smart glasses that will apply machine learning, speech recognition and vision technology to provide cross-cultural communication assistance in real-time.

Project researchers from Monash University's Vision and Language Group (VLG) at the Faculty of Information Technology (IT) said the goal of the program is to develop language processing technology that will recognise and adapt to the emotional, social, and cultural norms that differ across societies, languages, and communities.

"In addition to interpreting the content of the speech, the system will be 'translating' body language and facial expressions, providing cultural cues to prevent a breakdown in communications and ensuring smoother cross-cultural dialogue. During this project, we will be focussing mainly on negotiation-based dialogues," the researchers explained.

During a conversation, the dialogue assistance system may notice an imminent communication breakdown by analysing audiovisual cues

In addition to interpreting the content of the speech, the system will be 'translating' body language and facial expressions, providing cultural cues to prevent a breakdown in communications

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in real-time. The system can then send 'notifications' to the user's smart glass providing appropriate culturally attuned prompts to secure the negotiation.

For instance, the system may prompt the user to rectify the negotiation by making the other party feel more comfortable. It may then notify different ways the user can increase the level of comfort such as addressing the other person more respectfully as per their specific cultural norms.

Faculty of IT Deputy Dean (Research) Professor Maria Garcia de la Banda welcomed the support for research that will lead to innovation in the use of AI and data science for dialogue assistance technologies.

"Current AI-enabled systems are not capable of accurately analysing the many nuances of human communication or of providing useful assistance beyond basic machine translation," Professor Garcia de la Banda said.

"In this project our researchers will combine sophisticated speech technology with advanced multimedia analysis and cultural knowledge to build systems that provide a holistic solution."

The study will be conducted over the next three years in two phases. The first prototype will be released by March 2023.

This research will be led by the VLG from the Faculty of IT at Monash University in collaboration with researchers from the David Nazarian College of Business and Economics at California State University, Northridge and the Department of Biostatistics & Health Informatics, the Institute of Psychiatry, Psychology & Neuroscience at King's College London.

Monash University, 10 February 2022

<https://monash.edu>

A new upper limit on the mass of neutrinos

2022-02-14

In a milestone that will bear on future discoveries in nuclear and particle physics, today an international team including scientists from MIT announced that they have established a new upper limit on the mass of the neutrino subatomic particle: $0.8 \text{ eV}/c^2$.

Physicists say their understanding of the universe would remain incomplete without a detailed understanding the mass scale of neutrinos. Now, scientists with Karlsruhe Tritium Neutrino Experiment (KATRIN),

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located at Germany's Karlsruhe Institute of Technology (KIT), have pushed our understanding of neutrinos' mass with the new work, published in Nature Physics.

MIT has been a member of the KATRIN experiment since 2005. MIT researchers have helped construct the simulation framework used to understand the detector and developed tools used for the data analysis.

The team's first reported measurement in 2019 yielded a result of 1.1 eV/c². Scientists later broke the 1 eV/c², a testament to the precision of the technique. Further measurement of the neutrino's mass will continue through 2024.

To measure neutrino mass, KATRIN makes use of the beta decay of tritium, an unstable hydrogen isotope. The team was able to determine the mass of the neutrino via the measured energy of electrons released in the decay process. But to do so has necessitated a major technological effort: The experiment houses the world's most intense tritium source as well as a giant spectrometer to measure the energy of decay electrons with unprecedented precision.

"The idea of using radioactive decays to measure neutrino masses is as old as the idea of the neutrino itself," says Joseph Formaggio, lead principal investigator at MIT. "[Enrico] Fermi himself devised the technique back in the 1930s. But only now do we have the capabilities to make use of the technique to extract the neutrino mass with such precision."

Scientists at the Tritium Laboratory Karlsruhe, which hosts KATRIN, has allowed safe handling of the chemical in quantities needed to reach experimental goals, the team said. KATRIN scientists have also worked to reduce background noise in the KATRIN spectrometer, another key factor in establishing the new upper limit for the mass of the neutrino.

"KATRIN is an experiment with the highest technological requirements and is now running like perfect clockwork," Guido Drexlin, project leader at KIT and one of its co-spokespersons, said of the experiment.

Experimental data from the first year of measurements and then modeling based on a vanishingly small neutrino mass matched perfectly, the team reports. From this, a new upper limit on the neutrino mass of 0.8 eV/c² was determined. It is the first time that a direct neutrino mass experiment has entered the sub-eV mass range, they say, where the fundamental mass scale of neutrinos is suspected to reside.

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The KATRIN experiment will continue to take data over the next several years, eventually leading to a sensitivity of up to 4 times better than what we report today. "Hopefully a positive neutrino mass measurement is just around the corner," says Formaggio, "It will truly round out our knowledge of the fundamental particles in our Standard Model."

Formaggio is also working on a future experiment, called Project 8, that hopes to push the sensitivity to neutrino masses even further.

The KATRIN experiment is supported by funding agencies worldwide. Efforts in the United States are supported by U.S. Department of Energy (DOE) Office of Nuclear Physics.

MIT, 14 February 2022

<https://news.mit.edu>

Radiative cooling: Protecting ice from melting under sunlight, from iced food to glaciers

2022-02-17

Ice plays a significant role in many aspects of life, ranging from food preservation to ice sports and ecosystems, thereby providing incentive to protect ice from melting under sunlight. Fundamentally, ice melts under sunlight due to the imbalance of energy flow of incoming sunlight and outgoing thermal radiation. Radiative cooling can therefore balance the energy flows without energy consumption to sustainably protect ice. In a new report now published in Science Advances, Jinlei Li and a team of scientists in advanced microstructures, engineering, atmospheric sciences, and fine mechanics and physics, in China and the U.S., developed a hierarchically designed radiative cooling film using abundant and eco-friendly cellulose acetate molecules. The versatility of the materials provided effective and passive protection to ice in various forms and scales, under sunlight. The outcomes can effectively provide a scalable and tunable route to preserve ice and other critical elements of ecosystems.

Preserving ice

The process of ice preservation can impact daily ice or iced food, iced sports and iceberg levels at high altitudes or latitudes. Research shows how cold chain logistics alone consume 11 percent of global electricity, and approximately 2.5 percent of the world's greenhouse gas emission to preserve 40 percent of the world's food. Resource limitations have clearly arisen due to imbalanced energy flow due to ice melt under

Research shows how cold chain logistics alone consume 11 percent of global electricity, and approximately 2.5 percent of the world's greenhouse gas emission.

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sunlight, and it is of great practical significance to balance this and create a sustainable path for passive preservation of ice systems under sunlight. The bioengineering development in daytime radiative cooling offers a promising strategy to balance the energy flows. Materials scientists have used a range of materials and structures in these promising works, including multilayer or patterned photonic structures, porous poly film based on nanoparticles, cooling wood and super-white paints with solar reflectivity greater than 0.95. To preserve ice under sunlight, several stringent requirements must be in place. For example, a calculated increase of net radiation power from 70 to 110 Wm⁻² can prevent ice or ice food from melting without additional refrigeration. In this work, Li et al. designed a hierarchical film based on abundant and eco-friendly cellulose acetate (CA) to achieve high cooling performance.

Biodegradable cellulose acetate (CA) materials for enhanced cooling performance

The material showed favorable traits for high-performance, large-scale cooling applications due to broadband and high mid-infrared emissivity. The tailored pores functioned as effective scattering centers for incoming solar radiation to minimize thermal load on ice under sunlight to realize passive protection for ice systems. Li et al. chose CA to construct the film due to its eco-friendly abundance as a biodegradable film that can undergo degradation in nature. The team derived raw cellulose acetate (CA) from natural cellulose, which exists in the plant cytoderm. To design, develop and characterize the cellulose acetate film, the team showed how the impact of broadband and the effective reflection of sunlight allowed the realization of radiative cooling under sunlight. Based on the theoretical model, Li et al. showed a cellulose acetate based film with a porous structure, with multiple pores sizes to support strong scattering and reflection of sunlight. To accomplish this, they developed a CA molecule-based scalable film using roll-to-roll electrospinning. They presented the microscopic appearance of the product with nanofibers connected to form multiple pores with varying sizes, to ideally scatter sunlight.

The design and development of cellulose acetate (CA) for ice and iced food preservation

During its mechanism of function, the emissivity of high mid-infrared was critical to conduct heat flow to the cold universe (3 K) to realize radiative cooling. The hierarchically designed CA film showed a broadband mid-infrared emissivity, with an emissive peak to cool large-scale ice at high

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latitudes as described using modeling experiments. After achieving the desired optical properties for CA films, Li et al. measured the cooling temperature and power of the films to understand their radiative cooling performance. The experimental setup achieved a cooling power of up to 110 Wm⁻² and a cooling temperature approximating 12 degrees Celsius under direct sunlight irradiation. The resulting CA film with excellent radiative cooling performance were suited for flexible and portable outdoor ice and iced food preservation. Compared to the newly designed CA film, the team used white paper aluminum (Al) film, and polyethylene terephthalate (PET)-Al-polyethylene films (PET-Al-PE) as controls to show lower solar reflectivity. They next monitored the temperature evolution of iced food wrapped in different materials under natural outdoor sunlight to show longer preservation of iced food covered with the CA film below 0 degrees Celsius for 5.5 hours owing to optical properties of the packing materials. The material provided a very effective mode of passive preservation with 98 percent integrity after 80 minutes of sunlight.

Protecting ice and snow and modeling the cooling effects for ice at high latitudes.

Since the solar input and mid-infrared output can be balanced for outdoor ice and iced food preservation, Li et al. considered this a dominant factor to maintain the ecosystem at high altitudes. While ice and snow are two representative geomorphologies, they maintain different solar reflectivity, although with similar mid infrared emissivity. The team showed passive cooling effects of the film for ice and snow to confirm protective effects for ice under sunlight. The material also showed excellent protection for snow surfaces at high altitudes during field testing, to provide direct proof of radiative cooling effects, to slow the melt of local glaciers. The researchers then modeled the cooling effects for ice at high latitudes with global climate impact on the long-term. They accomplished this by studying an iceberg by using a thermodynamic model to show how icebergs melted by approximately 1-m in the summer. In contrast, the CA film facilitated preservation and 1-m thickening of the iceberg. Using climate model experiments, the scientists showed how the approach effectively protected ice systems at high latitudes and credited the design of CA films and their excellent radiative cooling capacity, to solar reflectivity and other properties of the material, which decreased the surface temperature at high latitudes, by 4 degrees Celsius. The biodegradability of the material also contributed to the diversity, while soil exposure tests verified the potential to offer environmental-friendly protection for ice and snow at different latitudes.

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In this way, Jinlei Li and colleagues showed how a hierarchically designed CA film effectively provided eco-friendly and scalable radiative cooling under sunlight. The team highlighted the mechanism of function and the biodegradability of the material, and its implications to protect ice in daily life and ecosystems. The work calls for more consistent and collective global efforts to maintain a sustainable pathway to protect ice melting with potential climate impact.

Phys Org, 17 February 2022

<https://phys.org>

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Can the Salton Sea geothermal field prevent the coming lithium shortage?

2022-02-16

University of California, Riverside scientists will join a first-of-its-kind effort to map out California's so-called "Lithium Valley," and learn whether it can meet America's urgent demand for lithium in a sustainable, environmentally friendly way.

Lithium is required for making electric vehicle batteries and other devices that store and use electricity. As the world transitions away from fossil fuels and electric vehicles become increasingly popular, an acute deficit looms in lithium supply: its price increased by over 400% in 2021. The shortage could put the brakes on many automakers' plans to create all-electric inventory by 2035.

To help ensure America's supply, the U.S. Department of Energy's Geothermal Technologies Office is supporting this new lithium study with \$1.14 million. It is being led by Lawrence Berkeley National Laboratory, in partnership with UCR and Geologica Geothermal Group, Inc.

"We hope that our collaborative research will provide independent, objective scientific data on the origin, extent and sustainability of the extractable lithium that is present in the Salton Sea geothermal brines," said UCR geochemist Michael McKibben, who has been studying the Salton Sea geothermal field since the 1970s.

"We also seek to identify any environmental issues associated with direct lithium extraction from geothermal brines, even though they appear to pale in comparison to the significant environmental problems associated with traditional open pit and evaporative pond mining of lithium that occurs in the rest of the world," he said.

"Extraction from the deep hot brines will not have any direct impact on the Sea itself, but the process does require some water use and some chemical reagents," McKibben said.

Geothermal energy is a clean, renewable form of energy in which hot fluids are produced from deep underground, and the steam from their boiling is then used to generate electricity. Lithium would be extracted from the spent, cooled brine before it is reinjected into the ground.

Currently, most of the world's lithium is either mined from open pits in China and Australia or extracted from salar deposits — salt lake flats — in South America. These methods run the risk of groundwater contamination,

As the world transitions away from fossil fuels and electric vehicles become increasingly popular, an acute deficit looms in lithium supply: its price increased by over 400% in 2021.

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water depletion and air pollution. In addition, these methods aren't extracting lithium quickly enough to meet demand.

The potential size of the lithium resource below the surface of the Earth near the Salton Sea is staggering. Governor Gavin Newsom recently called California the "Saudi Arabia of lithium," and the state established the Lithium Valley Commission last year to report on the opportunities.

"The Salton Sea geothermal system is the primary potential geothermal resource for lithium in the United States, and it's a world-class resource," said Pat Dobson, the Berkeley Lab scientist leading the project. "But there is a wide range of estimates in terms of the size of the resource, and also not a great understanding of where the lithium comes from, the rate at which it would decline over time with extraction of lithium from the geothermal brines, and whether it would be replenished by the remaining lithium in the host rocks."

It is also not yet clear whether all of the lithium is extractable, or whether there is any risk of inducing an earthquake from expanding geothermal production in the area. The project will address these questions, as well as questions about the efficiency of geothermal extraction.

McKibben and Maryjo Brounce, an assistant professor in the Department of Earth and Planetary Sciences, lead the UCR effort in this project. Brounce will use her energy dispersive and laser ablation instrumentation to map out where the lithium is located within the reservoir rocks, and what mineral form it's in. This characterization will then be used to assess the rate of resupply of lithium to reinjected geothermal fluids.

"We'll look at how quickly might you expect the resource to be regenerated – is it centuries? Decades?" Brounce said. "Those chemical reaction rates will depend pretty strongly on where in the rock lithium is stored, so it can help create a predictive tool."

The research team will be assisted with brine data from companies that have already started pilot lithium extraction operations at the Salton Sea.

"We want to use the existing brine data to develop a predictive tool for how much lithium is present in brine as a function of its temperature and salinity, in order to estimate how much lithium is present in those parts of the geothermal field that have not yet been drilled out and explored," said McKibben. "So far only about a third of the known thermal resource in the field has been drilled into."

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Ultimately, the researchers hope that in addition to forming the basis for a new domestic battery industry, geothermal lithium extraction could lead to economic growth in Imperial County, which has the lowest per capita income in the state.

"We need to get students in Imperial County and elsewhere to understand that they can have lucrative careers involving green energy near the Salton Sea," McKibben said. "This is an opportunity to do that."

UC Riverside, 16 February 2022

<https://news.ucr.edu>

How superbugs use mirror images to create antibiotic resistance

2022-02-17

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a bacterial infection that has become resistant to most of the antibiotics used to treat regular staph infections. Duke University computer scientist Bruce Donald and collaborators at the University of Connecticut are working to develop new enzyme inhibitors to fight MRSA. In research published in PLOS Computational Biology, the team discovered how a single small mutation makes a big difference in drug efficacy.

They examined dihydrofolate reductase (DHFR), an enzyme that antibiotics target to fight MRSA. Drugs that inhibit DHFR work a bit like locks and keys; they bind to enzymes in MRSA, which have a specific three-dimensional structure that only allows molecules that fit precisely to attach to them.

A mutation can change the structure of a bacterial enzyme and cause drugs to lose effectiveness. The F98Y mutation is a well-known resistance mutation. A slight change in the 98th amino acid in the DHFR enzyme changes a phenylalanine to a tyrosine. "Those two amino acids are structurally similar," said Graham Holt, grad student in the Donald lab, "but the mutation has a huge effect on the efficacy of the inhibitors." In essence, it changes the lock.

Pablo Gainza, Ph.D., former graduate student in the Donald lab, thought he should be able to predict this mutation using OSPREY, a suite of programs for computational structure-based protein design developed in the Donald lab. But he couldn't. After knocking down hypothesis after

A mutation can change the structure of a bacterial enzyme and cause drugs to lose effectiveness.

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hypothesis to figure out why he was unable to predict this mutation, he went back to examine the starting structure.

“We looked at the electron density data from the crystallographer and found something strange,” Donald said. In trying to determine the structure of the F98Y mutant, crystallographers used a computer program that—unbeknownst to them—flipped the chirality, or made a mirror image, of the NADPH cofactor to get a better fit. The “flipped” chemical species they discovered through their analysis exists in experimental conditions in the laboratory and plausibly in vivo.

“Using OSPREY, we discovered this flipped chirality,” Donald said, “which we believe happened because of the F98Y mutation.” As in 2-factor authentication, the single enzyme mutation and the flipped cofactor appear to conspire together to evade the inhibitor.

This “chiral evasion” changes the structural basis for resistance. But now Donald and colleagues know not only how a single small mutation changed the lock, but also the structure they need to make a better key—a better drug inhibitor.

“This is the first example of an enzyme that exploits the chirality of its cofactor in order to evade its inhibitors,” Holt said. “Now that we see this happening, that will help inform computational strategies to develop better inhibitors.”

The Donald lab showed that by taking flipped chirality into account, OSPREY’s predictions closely match experimental measurements of inhibitor potency. They worked with collaborators at the University of Connecticut who conducted biochemical experiments to test the theory and provide structural evidence.

“This is only the beginning of the story,” Donald said. “Our discovery of chiral evasion should lead to more resilient inhibitors: better drug designs.” Right now, most drug design is reactive, waiting for resistance to arise, which it always does. “We hope to make drug design proactive, by using our algorithms to anticipate resistance,” Donald said.

Phys Org, 17 February 2022

<https://phys.org>

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How Mars lost its oceans

2022-02-08

It has long been known that Mars once had oceans due in part to a protective magnetic field similar to Earth’s. However, the magnetic field disappeared, and new research may finally be able to explain why. Researchers recreated conditions expected in the core of Mars billions of years ago and found that the behavior of the molten metal thought to be present likely gave rise to a brief magnetic field that was destined to fade away.

Whether it’s because of science fiction or the fact that you can see it with your own eyes from Earth, Mars has captured the imagination of people for centuries. It’s one of the closest planets to us and has been studied with all manner of scientific instruments aboard the various unmanned space probes that have explored it and continue to do so. Yet, despite this, there are some big unanswered questions about Mars — the answers to which could even shed light on our own distant past and future, given that Earth, Mars and all our neighboring planets were born of the same cosmic stuff.

Some big questions about Mars have already been answered. For example, we know that many visible features of Mars are proof it used to have oceans and a protective magnetic field. But one question in particular had been on the mind of Professor Kei Hirose from the University of Tokyo’s Department of Earth and Planetary Science: There must have been a magnetic field around Mars, so why was it there at all, and why was it there so briefly? Compelled to answer this question, a team led by Ph.D. student Shunpei Yokoo in the Hirose lab explored a novel way to test something so distant from us in both time and space.

“Earth’s magnetic field is driven by inconceivably huge convection currents of molten metals in its core. Magnetic fields on other planets are thought to work the same way,” said Hirose. “Though the internal composition of Mars is not yet known, evidence from meteorites suggests it is molten iron enriched with sulphur. Furthermore, seismic readings from NASA’s InSight probe on the surface tell us Mars’ core is larger and less dense than previously thought. These things imply the presence of additional lighter elements such as hydrogen. With this detail, we prepare iron alloys that we expect constitute the core and subject them to experiments.”

The experiment involved diamonds, lasers, and an unexpected surprise. Yokoo made a sample of material containing iron, sulphur and hydrogen, Fe-S-H, which is what he and his team expect the core of Mars was

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once made from. They placed this sample between two diamonds and compressed it while heating it with an infrared laser. This was to simulate the estimated temperature and pressure at the core. Sample observations with X-ray and electron beams allowed the team to image what was going on during melting under pressure, and even map how the composition of the sample changed during that time.

“We were very surprised to see a particular behavior that could explain a lot. The initially homogeneous Fe-S-H separated out into two distinct liquids with a level of complexity that has not been seen before under these kinds of pressures,” said Hirose. “One of the iron liquids was rich in sulphur, the other rich in hydrogen, and this is key to explaining the birth and eventually death of the magnetic field around Mars.”

The liquid iron rich in hydrogen and poor in sulphur, being less dense, would have risen above the denser sulphur-rich, hydrogen-poor liquid iron, causing convection currents. These currents, similar to those on Earth, would have driven a magnetic field capable of maintaining hydrogen in an atmosphere around Mars, which in turn would have allowed water to exist as a liquid. However, it was not to last. Unlike the Earth’s internal convection currents which are extremely long lasting, once the two liquids had fully separated, there would have been no more currents to drive a magnetic field. And when that happened, hydrogen in the atmosphere was blown out to space by solar wind, leading to the breakdown of water vapor and eventually the evaporation of the Martian oceans. And this would all have taken place about 4 billion years ago.

“With our results in mind, further seismic study of Mars will hopefully verify the core is indeed in distinct layers as we predict,” said Hirose. “If that is the case, it would help us complete the story of how the rocky planets, including Earth, formed, and explain their composition. And you might be thinking that the Earth could one day lose its magnetic field as well, but don’t worry, that won’t happen for at least a billion years.”

University of Tokyo, 8 February 2022

<https://u-tokyo.ac.jp>

Sunny side up: can you really fry an egg on the footpath on a hot day?

2022-02-18

Aahh, the Australian summer. When the temperatures top 40 and only the bravest or most foolhardy would venture outside in bare feet, there’s

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a cherished old saying: “it’s so hot outside you could fry an egg on the footpath!”

But what does the science say? Does this claim stack up, or is it half-baked?

To answer this question, we need to understand the chemicals inside an egg, what happens to them during the cooking process, and whether the footpath really gets hot enough to drive these chemical changes.

The first and most obvious point is that the egg’s yolk and white are chemically very different. The white, which makes up about two-thirds of an egg’s mass, is roughly nine parts water and one part protein. The key here is that the protein’s structure changes if you heat it above a certain temperature.

About half the yolk’s mass is water, about a quarter is “fat”, about one-sixth is protein, and less than 5% is carbohydrates. The protein in the yolk is a completely different type of protein, but much like with the egg white, it’s how the protein responds to heat that gives us the texture of fried, scrambled, poached or hard-boiled eggs.

Ok, so how does this work?

We can think of proteins as being long chains of molecules called amino acids. In a raw egg, the protein is suspended in the watery mixture. The chain is curled up in a very particular way, held in shape by weak chemical bonds between different parts of the chain as it folds over on itself. This keeps it stable, and able to mix with the water.

But once it’s heated up, the heat energy starts to break these weak chemical bonds and the chain begins to uncurl, rearrange itself and stick together again in a completely different way.

Suddenly, these reconfigured clumps of protein molecules are no longer water-soluble, and so they solidify. This is why eggs get harder if you cook them for longer.

This process is called denaturation, and it can happen to any type of protein. Denaturation is what turns milk into curds and whey, and changes the texture of meat as it cooks.

For eggs, denaturation begins at around 60 °C, but this is likely to only slightly cook the egg whites, and the yolk will not turn solid at all.

As you slowly go from 60 °C to 70 °C, however, there is more heat energy available and all of the egg’s proteins now begin to denature. The egg

It’s how the protein responds to heat that gives us the texture of fried, scrambled, poached or hard-boiled eggs.

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white begins to turn gel-like and eventually rubbery, and the yolk begins to solidify into a viscous goo, before eventually becoming solid or even slightly powdery in texture.

Get the temperature right and this process unfolds nice and gradually, which means with a bit of practice you can get your eggs to turn out exactly how you like them.

Righto, so is a footpath hot enough for this?

That leaves us with the crucial question: how hot does pavement get on a scorching summer day? Does it reach the almost 70 °C you would need for a footpath fry-up?

This depends on a lot of factors, including the air temperature, direct sunlight, the footpath material and even its colour. Black-painted concrete, for example, absorbs more heat than white or unpainted concrete.

All in all, at the peak of these conditions, on a boiling summer day, a footpath can potentially just about reach the right temperature. But sadly, that's still not enough to sizzle an egg.

First, concrete is a poor conductor, so it will transfer heat to the egg much more slowly than a metal frying pan. Second, after cracking the egg onto the footpath, the footpath's temperature will drop slightly.

So if you were hoping for a cheap way to cook your sunny-side-up eggs on the footpath this summer, you might be disappointed. It's much wiser to head back indoors to the kitchen. Your egg will be hotter, and you'll be much cooler.

The Conversation, 18 February 2022

<https://theconversation.com>

Why can't we get our drinking water from the ocean?

2022-02-18

For centuries, people have been trying to divine freshwater from the ocean. Ships in the 16th century carried small distilleries that could be used in the event of an emergency to boil seawater. But trying to do this on a large scale cooks up equally large-scale problems.

"It's an energy question," says Frank Rogalla. "To desalinate water takes 10 times more energy than for any other water source." The carbon footprint

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of desalinating water is sizeable: industrial-sized desalination plants like Saudi Arabia's huge Ras al-Khair typically need their own power stations.

Although early desalination plants were based on boiling salt water, an energy crisis in the 1970s accelerated the rise of reverse osmosis plants, which use high pressures to push salt water through a membrane that leaves the salt trapped on one side. This uses about half as much energy as boiling the water, but still demands around 4 kWh to produce a cubic meter of potable water.

That makes other strategies for drought-stricken communities, such as water conservation and reuse, much more pragmatic. "Desalinated water is too expensive for most use cases," adds Rogalla. "It is expensive in infrastructure and energy costs, so it's a last resort." He says that desalination plants constructed in Spain fell into disuse when farmers refused to pay the high cost of the water they produced.

However, there are some tricks that might make salt water more palatable. The first is to avoid the oceans. "Rather than seawater, desalination typically uses brackish water as a starting point," explains Rogalla. This might come from aquifers that are considered too salty to use untreated, or estuarine sources. This is less salty than seawater, so requires less energy to desalinate.

In the EU-funded MIDES project, Rogalla led efforts to make the process even more efficient with the help of bacteria. These microbes were used to help carry salt molecules across a membrane, further reducing the energy needed to create drinkable water. Rogalla says: "The energy required for desalination is directly proportional to salt concentration, so if we can kick-start the process with microbial energy, we reduce the electricity needed."

For every liter of fresh water desalination plants produce, there is a leftover liter of water that is now twice as salty. Rogalla sees this as an opportunity: "There are nice salts in the water, like calcium and magnesium, ones that normally cost a lot to obtain." His team is exploring ways to extract the various minerals dissolved in this waste brine for commercial use.

So with increasing water scarcity, does Rogalla see desalination as the future? "It's an emergency measure, and only one part of a solution," he remarks. "First you should minimize use, and then reuse water when you

The carbon footprint of desalinating water is sizeable: industrial-sized desalination plants like Saudi Arabia's huge Ras al-Khair typically need their own power stations.

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can. Desalination is only for the highest need. Without these other actions, it is simply not sustainable.”

TechXplore, 18 February 2022

<https://techxplore.com>

Altruism in birds? Magpies have outwitted scientists by helping each other remove tracking devices

2022-02-22

When we attached tiny, backpack-like tracking devices to five Australian magpies for a pilot study, we didn't expect to discover an entirely new social behaviour rarely seen in birds.

Our goal was to learn more about the movement and social dynamics of these highly intelligent birds, and to test these new, durable and reusable devices. Instead, the birds outsmarted us.

As our new research paper explains, the magpies began showing evidence of cooperative “rescue” behaviour to help each other remove the tracker.

While we're familiar with magpies being intelligent and social creatures, this was the first instance we knew of that showed this type of seemingly altruistic behaviour: helping another member of the group without getting an immediate, tangible reward.

Testing exciting new devices

As academic scientists, we're accustomed to experiments going awry in one way or another. Expired substances, failing equipment, contaminated samples, an unplanned power outage – these can all set back months (or even years) of carefully planned research.

For those of us who study animals, and especially behaviour, unpredictability is part of the job description. This is the reason we often require pilot studies.

Our pilot study was one of the first of its kind – most trackers are too big to fit on medium to small birds, and those that do tend to have very limited capacity for data storage or battery life. They also tend to be single-use only.

A novel aspect of our research was the design of the harness that held the tracker. We devised a method that didn't require birds to be caught again to download precious data or reuse the small devices.

Most trackers are too big to fit on medium to small birds, and those that do tend to have very limited capacity for data storage or battery life.

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We trained a group of local magpies to come to an outdoor, ground feeding “station” that could either wirelessly charge the battery of the tracker, download data, or release the tracker and harness by using a magnet.

The harness was tough, with only one weak point where the magnet could function. To remove the harness, one needed that magnet, or some really good scissors. We were excited by the design, as it opened up many possibilities for efficiency and enabled a lot of data to be collected.

We wanted to see if the new design would work as planned, and discover what kind of data we could gather. How far did magpies go? Did they have patterns or schedules throughout the day in terms of movement, and socialising? How did age, sex or dominance rank affect their activities?

All this could be uncovered using the tiny trackers – weighing less than one gram – we successfully fitted five of the magpies with. All we had to do was wait, and watch, and then lure the birds back to the station to gather the valuable data.

It was not to be

Many animals that live in societies cooperate with one another to ensure the health, safety and survival of the group. In fact, cognitive ability and social cooperation has been found to correlate. Animals living in larger groups tend to have an increased capacity for problem solving, such as hyenas, spotted wrasse, and house sparrows.

Australian magpies are no exception. As a generalist species that excels in problem solving, it has adapted well to the extreme changes to their habitat from humans.

Australian magpies generally live in social groups of between two and 12 individuals, cooperatively occupying and defending their territory through song choruses and aggressive behaviours (such as swooping). These birds also breed cooperatively, with older siblings helping to raise young.

During our pilot study, we found out how quickly magpies team up to solve a group problem. Within ten minutes of fitting the final tracker, we witnessed an adult female without a tracker working with her bill to try and remove the harness off of a younger bird.

Within hours, most of the other trackers had been removed. By day 3, even the dominant male of the group had its tracker successfully dismantled.

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We don't know if it was the same individual helping each other or if they shared duties, but we had never read about any other bird cooperating in this way to remove tracking devices.

The birds needed to problem solve, possibly testing at pulling and snipping at different sections of the harness with their bill. They also needed to willingly help other individuals, and accept help.

The only other similar example of this type of behaviour we could find in the literature was that of Seychelles warblers helping release others in their social group from sticky *Pisonia* seed clusters. This is a very rare behaviour termed "rescuing".

Saving magpies

So far, most bird species that have been tracked haven't necessarily been very social or considered to be cognitive problem solvers, such as waterfowl and raptors. We never considered the magpies may perceive the tracker as some kind of parasite that requires removal.

Tracking magpies is crucial for conservation efforts, as these birds are vulnerable to the increasing frequency and intensity of heatwaves under climate change.

In a study published this week, Perth researchers showed the survival rate of magpie chicks in heatwaves can be as low as 10%.

Importantly, they also found that higher temperatures resulted in lower cognitive performance for tasks such as foraging. This might mean cooperative behaviours become even more important in a continuously warming climate.

Just like magpies, we scientists are always learning to problem solve. Now we need to go back to the drawing board to find ways of collecting more vital behavioural data to help magpies survive in a changing world.

The Conversation, 22 February 2022

<https://theconversation.com>

How NASA plans to destroy the International Space Station, and the dangers involved

2022-02-18

NASA has announced plans for the International Space Station (ISS) to be officially decommissioned in 2031. After dozens of launches since 1998 got

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the station up and into orbit, bringing it down will be a feat of its own—the risks are serious if things go wrong.

NASA's plans for the decommissioning operation will culminate in a fiery plunge into the middle of the Pacific Ocean—a location called Point Nemo, also known as the "spacecraft graveyard," the furthest point from all civilisation.

Finding Point Nemo will be the final stop in a complex and multi-staged mission to transition the operations of the ISS to new commercial space stations, and to bring the remaining structure safely down to Earth.

Originally commissioned for a 15-year lifespan, the ISS is outliving all expectations. It has already been in operation for 21 years, and NASA has given the go-ahead for one more decade, thereby doubling its total planned time in orbit.

Purpose of the ISS

The ISS has enabled one giant leap for science and collaboration across mankind, involving five different space agencies (US, Russia, Europe, Canada and Japan). The modules and parts of the ISS have been built progressively by many different countries, only coming into contact for the first time in space.

The monumental conglomerate structure now stretches the length of a football field and is the largest human-made object in space. It is visible by the naked eye from Earth while it completes its 16 daily orbits, passing 400km above the Earth's surface.

Research in the so-called microgravity environment of the ISS has yielded breakthroughs in drug discovery, vaccine development and medical treatments in the last decade. The ISS also helps to monitor Earth's ecosystems and natural disasters in real time. It is used to test future spacecraft technologies and to study health effects of long term spaceflight for the possibility of future human exploration of the solar system.

Despite onboard research gaining momentum, NASA has noticed signs of infrastructure and components slowing down. For every orbit around the Earth, the ISS gets scorched by solar radiation on one side, and freezes on the other. These thermal extremes cause cyclic expansion and contraction which wears the material. Space radiation chars the transparent glass on the solar cells which are used to power the station, and repeated docking

The decommissioning operation will culminate in a fiery plunge into the middle of the Pacific Ocean—a location called Point Nemo, also known as the "spacecraft graveyard"

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and undocking causes gradual structure degradation, which will ultimately lead to its demise.

The rise of flying space junk also poses unplanned and catastrophic risk of destruction. In 2016, a fly-away speck of paint chipped a window, and just last year, ISS crew went into evacuation standby when Russia obliterated a dead satellite with a missile, causing thousands of pieces of debris to fly by the station at 5km per second. Despite this, NASA assesses there is “high confidence” the station will see it through to the end of 2030.

The decommissioning operation

While NASA has committed to maintaining the station until 2030, its partner organizations are yet to officially sign on, meaning the final decision to de-orbit will depend on politics as much as engineering.

If degradation or unplanned damage occurs before the official decommissioning, a free-falling ISS poses serious dangers. In fact, it would not be the first space station to fall out of the sky. In 1979, NASA’s Skylab station was not re-fueled in time and came crashing down, out of control, leaving chunks of the station scattered across Australia. While no one was harmed, this led to reforms and “design for demise” guidelines.

Design for demise is an important principle for the engineering of satellites and other orbiting space infrastructure. Objects that fall freely from orbit must disintegrate into tiny pieces to make sure they don’t pose a danger to people on the ground.

The ISS is too large to satisfy the design for demise principle, which is why we need special operations for de-orbit. Experts estimate that if it were to crash down uncontrolled in a metropolitan area, the worst case scenario could be on the scale of a “9/11 event.” However, this is highly improbable.

In the planned, controlled, de-orbit operation for the ISS, newly built modules will first detach from the main structure and remain in orbit to eventually recombine as parts of future space stations. The ISS will then be gently decelerated by onboard thrusters, causing its orbiting altitude to gradually lower over the course of a few months.

The remaining descent will be more rapid, but controlled by a series of spacecrafts sent to attach and steer the structure as it begins to plummet towards Earth. As it re-enters the atmosphere the majority of the structure will burn away, however the remaining mass should remain on a targeted trajectory to its deep-sea resting place.

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A Russian space station was previously brought safely down in the same way, however the ISS is approximately four times larger, so an operation on this scale remains untested.

New era

Before complete de-orbit in 2031, the ISS will first undergo a transition phase to sustain the crucial scientific research currently being conducted, and to form the basis of new industries in space.

Jeff Bezos’ Blue Origin recently announced plans to replace the ISS with the company’s privately-operated space station. Other key players include Northrop Grumman and Axiom Space (partnered with SpaceX) who have a contract to start building modules off of the existing ISS as early as 2024.

There are also plans for a Russian space station which is likely to comprise of modules detached from the existing ISS. Meanwhile China launched the first module of their independent Tiangong Space Station last year, and plan to complete its expansion in the coming months.

At present, NASA and its partner agencies oversee the use of their jointly owned infrastructure and are consulted on operations due to their governing expertise. However, times are changing and NASA now purchases seats on board spacecraft owned by SpaceX. Ultimately, NASA will become just another customer of commercial operators.

Phys Org, 18 February 2022

<https://phys.org>

Are there any giant animals humans haven’t discovered yet?

2022-02-20

In 2020, researchers saw for the first time what may be the longest animal ever. The creature, spotted in a deep-sea canyon off Australia, was a roughly 150-foot-long (45 meters) siphonophore. Each member of this group of species is made up of lots of smaller animals called zooids, which connect to form a long, string-like colony similar to a coral but that swims freely in the ocean.

Given it took so long for humans to set eyes on this ginormous siphonophore, it raises the question, are there more giant animals humans haven’t discovered yet? The answer is almost certainly yes. Scientists are

Siphonophores live between about 2,300 and 3,280 feet (700 to 1,000 m) below the surface, according to the Monterey Bay Aquarium in California.

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still learning about life on Earth and the siphonophore is one of several giants that humans have found in recent decades.

Siphonophores live between about 2,300 and 3,280 feet (700 to 1,000 m) below the surface, according to the Monterey Bay Aquarium in California. But scientists don't always have to go to such depths to find new colossal creatures. In 2011, a previously unknown whale species washed up on a New Zealand beach. Scientists identified the giant in 2021 as a new member of the beaked whale family — a relatively unknown group of deep-diving whales that are rarely seen alive, according to Whale and Dolphin Conservation, an international charity that works to protect whales and dolphins.

While researchers are still only beginning to unlock the secrets of the deep ocean, they're a lot more familiar with large animals living on land. African bush elephants cut unmistakable silhouettes on the savanna. Standing up to 13 feet (4 m) high and weighing up to 11 tons (10 metric tons), they are the largest living land animals on Earth, according to The Nature Conservancy. It's hard to imagine we could miss a massive, elephant-size creature roaming our planet.

Perhaps this is why most research into large land animals tends to lead to reclassifications rather than brand-new discoveries. For example, in 2017, researchers determined that an isolated group of orangutans on the Indonesian island Sumatra was a distinct species from other orangutans and named them Tapanuli orangutans (*Pongo tapanuliensis*), Live Science previously reported.

But humans already knew these orangutans existed, and at less than 5 feet (1.5 m) tall, these primates aren't exactly giants. Meanwhile, there's no physical evidence for the existence of Bigfoot, Nessie or other massive mythological monsters that are very different from what's already been identified.

The largest unknown terrestrial animals tend to be dug up rather than seen alive. Humans are still chipping away at Earth's geologic history and finding previously unknown giants in the fossil record. Chief among the recently discovered behemoths is a group of supermassive sauropod dinosaurs called titanosaurs — giant, long-necked herbivores.

"We're talking about the same amount of meat walking around in one of these animals as in potentially six or seven fully grown bull African elephants," Paul Barrett, a paleontologist at the Natural History Museum in London, told Live Science.

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Some of the biggest titanosaurs were discovered relatively recently in Argentina and yet are contenders for the largest terrestrial animals on record. There is some ongoing scientific debate about their sizes, but the heaviest and potentially largest of all titanosaurs was likely *Argentinosaurus*.

Discovered in 1993, *Argentinosaurus*' bones suggest that it was 115 feet (35 m) long and weighed up to 77 tons (70 metric tons), according to London's Natural History Museum. However, new size rivals are still emerging. In 2014, *Patagotitan mayorum* burst onto the paleontology scene in the 66-ton (60 metric tons) range and reached about 122 feet (37 m) long, Live Science previously reported. In 2021, researchers announced another titanosaur discovery that could be even bigger, but researchers have yet to fully excavate the specimen.

Barrett thinks there will be more massive titanosaur discoveries. The rate of these finds has increased along with a broader upward trend in fossil discoveries, he said, as more paleontologists are looking in a wider variety of places than in the past.

"Historically, most of that work was done in places where the people publishing were based — so, in North America and Europe," Barrett said. "In the last 30 to 40 years, that knowledge base has spread much more widely internationally."

Despite this increased rate of discovery, the evidence for giant extinct beasts isn't always forthcoming. *Argentinosaurus*, the top seed for the largest dinosaur, is known only from about a dozen bones.

"It's actually quite difficult to become a fossil in the first place," Barrett said. For an animal to be preserved in rock, a lot of things have to go right. For example, the animal's bones need to be completely buried quickly in the right conditions, such as mud or sand, and they cannot be eaten or taken away by a predator or erode over time.

"If you're a sauropod and you're 30 meters [100 feet] long, your chances of getting buried in one go are actually quite low," Barrett said. "There's always probably going to be a bit of you sticking out."

Scientists don't have a theoretical maximum size for a land animal. If you include marine animals, blue whales (*Balaenoptera musculus*) are the heaviest animals on record, with a maximum weight of at least 150 tons (136 metric tons). However, they don't have to hold their weight up on land as titanosaurs did.

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There must be a limit to how big animals can grow and still support themselves under the weight of gravity and get enough energy to keep their massive bodies moving. Barrett said he would be very surprised to see dinosaur discoveries make a big jump up in terms of size, but paleontologists have been surprised before.

"I don't want to say that we're close to that limit, because tomorrow someone could find something even bigger," Barrett said.

Live Science, 20 February 2022

<https://livescience.com>

Placenta may hold clues for early autism diagnosis and intervention

2022-02-18

New UC Davis MIND Institute research has identified a novel human gene linked to fetal brain development and autism spectrum disorder (ASD). The discovery also links the gene to the mother's early prenatal vitamin use and placental oxygen levels.

In a study published Feb. 16 in *Genome Biology*, the researchers used genomic sequencing to find a DNA methylation signature in the placenta of newborns eventually diagnosed with autism. This signature mark was linked to early fetal neurodevelopment.

"By taking an unbiased approach to investigating placental DNA methylation differences, we discovered a novel gene in a poorly mapped region of the genome associated with autism," said Janine LaSalle, lead author on the study and professor of microbiology and immunology at UC Davis Health.

ASD is a complex neurological condition linked to genetic and environmental factors. The U.S. Centers for Disease Control and Prevention (CDC) estimates that one in 44 children are diagnosed with ASD. It is much more prevalent in males than females.

Why studying the placenta is important

The placenta supports fetal development in the uterus. It regulates oxygen supply and metabolism and provides hormones and neurotransmitters critical for the fetus' developing brain.

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"The placenta is an often misunderstood and overlooked tissue, despite its importance in regulating and thereby reflecting events critical to brain development in utero. It is like a time capsule for finding things that happened in utero. For decades, hospital births have thrown away placentae despite this tissue being a gold mine for finding molecular clues to child outcomes," LaSalle said.

During pregnancy, the fetus might experience oxidative stress, an imbalance of free radicals and antioxidants in the body. This is common in normal brain development. However, in some cases, exposure to environmental factors such as air pollution and pesticides can lead to excessive oxidative stress. This state can lead to cell and tissue damage or delayed neurodevelopment.

"Oxidative stress is normal. But excessive oxidative stress may come from environmental exposures linked to ASD such as air pollution, pesticides, maternal obesity and inflammation," LaSalle said.

The epigenome is a set of chemical compounds and proteins that tell the DNA what to do. These compounds attach to DNA and modify its function. One such compound is CH₃ (known as the methyl group) which leads to DNA methylation. The neonatal epigenome can reflect past interactions between genetic and environmental factors during early development. It may also influence future health outcomes.

The placenta is a promising tissue for identifying DNA methylation changes at genes that also function in the fetal brain. This study examined the association of ASD with placental DNA methylation.

Finding factors in mother's placenta that might predict autism

The researchers studied the development of 204 children born to mothers enrolled in the MARBLES and EARLI studies. These mothers had at least one older child with autism and were considered with higher probability of having another child with ASD. When these children were born, the mothers' placentae were preserved for future analysis.

At 36 months, the children got diagnostic and developmental assessments. Based on these tests, the researchers grouped the children under "typically developing" (TD), "with ASD" and "non-typical development" (Non-TD).

The researchers also extracted and quantified the DNA from the placenta tissues. They divided the placenta samples into discovery, replication and specificity replication groups.

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For the discovery group, they split and sequenced 92 samples (46 ASD, 46 TD) from the MARBLES study using whole-genome bisulfite sequencing (WGBS) and whole-genome sequencing (WGS). To determine if differential methylation was reproducible in a different population, the replication group included WGBS data from 16 ASD and 31 TD samples from the EARLI study.

The specificity replication group had 21 ASD, 13 Non-TD and 31 TD placenta samples from the MARBLES study. The researchers used these samples to determine if methylation changes were specific to ASD.

Finally, they performed whole genome sequencing on 41 ASD and 37 TD MARBLES children.

Placenta to reveal insights into genes related to ASD

The researchers identified a block of differential methylation in ASD at 22q13.33, a region in chromosome 22 not previously linked to ASD. They located and characterized a novel gene known as LOC105373085 within that region and renamed it NHIP (neuronal hypoxia inducible, placenta associated).

To understand the function of this gene, they detected the levels of NHIP expression in human cell lines and brain tissue. They tested the responsiveness of NHIP to hypoxia, a state of low oxygen levels in the tissues. The researchers found that NHIP is a gene that gets turned on in neurons following hypoxia and regulates other gene pathways with functions in neuronal development and response to oxidative stress. Higher NHIP levels increased the cell division in an embryonic cell line.

This is important because in the placenta, hypoxia triggers placental cell division to make further contact with maternal blood vessels to supply enough oxygen for the developing brain.

The researchers also discovered that NHIP was less activated in ASD placenta and brain compared to TD samples, supporting a protective role for NHIP in preventing ASD.

"We found that the NHIP gene is active in the brain, responsive to oxidative stress, and influences expression of other known genes associated with autism," LaSalle said. "In most pregnancies, the placenta experiences some inevitable levels of stress. We think that NHIP is there to buffer the effects of excessive oxidative stress."

Prenatal vitamins and autism

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Another remarkable finding from the study was the role prenatal vitamins play in regulating the work of NHIP. Prenatal vitamins are high in folic acid and can reduce oxidative stress.

Prenatal vitamins use during the first month of pregnancy showed a significant protective effect among individuals with genetic differences at 22q13.33 NHIP region. Taking prenatal vitamins in the first month of pregnancy seems to provide essential metabolic elements to counteract the genetic inheritance of reduced NHIP responsiveness to oxidative stress.

"In line with previous studies, we found that taking a prenatal vitamin is essential when planning a pregnancy," said LaSalle. "Findings from our study provide key insights that may help in identifying newborns more likely to develop autism and getting them into an earlier intervention or just knowing to watch them sooner."

The researchers pointed out that these results will require further replication before being used diagnostically.

Medical Xpress, 18 February 2022

<https://medicalxpress>

What do ants smell like?

2022-02-19

Skunks are notoriously stinky. The musk ox, true to its name, emits a musky scent during mating season. And for some lucky owners, dog paws smell like corn chips. But these are not the only members of the animal kingdom that are smelly. Perhaps one of the most peculiar stinky animals is right under your nose: ants.

Most people have come across ants in their lives. So why don't most people know that ants smell?

There are more than 13,000 ant species. When Clint Penick, an assistant professor of ecology, evolution and organismal biology at Kennesaw State University in Georgia, tells people that he studies these critters, he often gets this question: "Red ants or black ants?" But there are more useful and creative ways to distinguish ant species, Penick told Live Science. One of them is by smell.

"If I find a species I'm familiar with, I might pick it up and crush it," he said. "The smell can sometimes help me narrow down which group of ants it might be from."

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"If I find a species I'm familiar with, I might pick it up and crush it," he said. "The smell can sometimes help me narrow down which group of ants it might be from."

Not all ant species are odorous enough for the human nose to detect their scent. Of those that are, the scent may be mild, and some can be smelled only after being crushed, Penick said. However, some ants can be smelled from a distance if they're in a large enough colony.

There are four main smells that ants are known to emit. The first is citronella — from the aptly named citronella ants, also known as larger yellow ants (*Lasius interjectus*) and smaller yellow ants (*Lasius claviger*) — although some people describe these ants' odor as lemon. "The citronella smell is thought to be something that they use to defend themselves or make them distasteful to predators," Penick said.

The smell of trap-jaw ants (*Odontomachus*) is anything but distasteful — it smells like chocolate. These predator ants produce an alarm pheromone in a gland in their head to let other members of the colony know when they're in danger, and it emits a chocolate-like aroma. Sadly, these ants have to be crushed to be smelled. "I've done it only once to see if it was true but normally try to avoid it," Penick said.

Some ants, including wood ants (*Formica*) and carpenter ants (*Camponotus*), have a distinct smell they use for defense in place of a stinger. "They can stop a bear with formic acid if they all come together and spray," Penick said. "But one on their own is just enough to give you a slight little wisp of vinegar." However, some people report not being able to smell formic acid; the ability to smell it may be genetic.

The final ant smell used to be controversial, but Penick said he and a colleague settled the debate with a 2015 study published in the journal *American Entomologist*. Odorous house ants (*Tapinoma sessile*) have long been regarded as smelling like coconut, or sometimes like rotten butter. But when Penick sniffed one for the first time, he was hit by the scent of blue cheese. So he shipped off the three foods — including butter that he let rot in his kitchen — and ant samples to a friend's lab, where a tool called a gas chromatograph analyzed the volatile compounds released into the air. Then, they compared the compounds that made up the smells of the foods and the ants. The team discovered a match between the ants and the blue cheese.

At the same time, Penick had people rate what they thought the ant smelled like. Most people said blue cheese, but some thought it smelled

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Curiosities

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like rotted coconut. So Penick rotted a coconut in his backyard and found a mold growing on it that, sure enough, is the same mold (*Penicillium roqueforti*) that's used to produce blue cheese. Another mystery, solved.

Live Science, 19 February 2022

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