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ASIA PACIFIC

Food Standards Australia New Zealand CEO year in review

2025-12-05

As 2025 draws to a close, I reflect with pride on the progress we have made with our food regulation system partners and stakeholders to keep food safe and trusted in a rapidly evolving food system environment.

This year, following rigorous scientific assessment and extensive stakeholder consultation, we delivered a range of important food regulatory outcomes for Australia and New Zealand. We strengthened national standards for egg production and processing to ensure eggs remain a safe and trusted staple in Australian households, updated the definitions for genetically modified (GM) foods to bring the Food Standards Code into line with current science and introduced mandatory energy labelling on alcoholic beverages to support informed consumer choice.

We approved cultured quail, the first cell-cultured food in Australia and New Zealand, marking a milestone in food innovation, while advancing preparatory work on front- and back-of-pack nutrition labelling. We also continued to gather the data and evidence needed to underpin standards development through national food surveillance, including progressing the 28th Australian Total Diet Study and a national study into antimicrobial resistance in the Australian food supply.

Read More

Food Standards Australia New Zealand, 05-12-25

https://www.foodstandards.gov.au/news/ceo-year-review

Behind the numbers: what's causing harm at work

2025-12-02

What causes injuries, illnesses and fatalities in Australian workplaces? In 2025, Safe Work Australia's Data Improvement and Analysis team set out to examine the mechanisms – the actions, exposures or events – that lead to work-related harm.

Whether it's a fall from height, a vehicle incident, or body stressing, each mechanism tells a story about the nature of workplace risk. Guided by

the Australian Work Health and Safety Strategy monitoring approach, the team analysed existing datasets to uncover patterns, compare causes of serious injury claims and fatalities, and identify the most common and costly mechanisms.

These findings will help to shape evidence and data-informed policies to make Australian workplaces safer and healthier.

A closer look into fatalities and serious injury claims

The analysis began by comparing the mechanisms behind serious workers' compensation claims and fatalities. In 2023-24p1, there were 146,700 serious claims2, while 188 traumatic injury fatalities were recorded in the 2024 calendar year. The data revealed notable differences in the types of incidents driving these outcomes.

Vehicle incidents emerged as the leading cause of work-related deaths in Australia, and by a significant margin. In 2024, they accounted for 42% of all workplace fatalities and more than triple the next most deadly mechanism, falls from a height (13%). Trucks, semi-trailers and lorries featured prominently in vehicle incident fatalities, with males making up 94% of vehicle-related deaths. The data also revealed a trend that older workers had an increased fatality risk in vehicle incidents.

Read More

Safe Work Australia, 02-12-25

https://www.safeworkaustralia.gov.au/media-centre/evidence-matters/2025/behind-numbers-whats-causing-harm-work

AMERICA

New York's Climate Law Experiences Another Delay

2025-11-25

ALBANY, N.Y. — Today, the Hochul administration filed an appeal of the Albany Supreme Court's decision that the New York Department of Environmental Conservation (DEC) violated the law by failing to promulgate regulations that ensure compliance with the state's emissions limits by the statutory deadline of January 1, 2024.

This appeal pauses the deadline of February 6, 2026 that was set by the court for DEC to issue regulations and will likely move the timeline to much later in the year.

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"This delay has already caused communities to miss out on at least $3 billion in investments to expand access to cleaner, cheaper energy today, including over $1 billion that could have directly lowered energy bills," said Kate Courtin, Senior Manager of State Climate Policy & Strategy at EDF. "There is robust evidence that, by moving forward with a well-designed Clean Air Initiative, Governor Hochul would cut costs for working families in New York while significantly cutting pollution.

"The Hochul administration is rejecting an opportunity to slash pollution, shield families from rising energy costs and push back against federal rollbacks that would stick New Yorkers with dirty, expensive energy sources."

Read More

EDF, 25-11-25

https://www.edf.org/media/new-yorks-climate-law-experiences-another-delay

New Jersey Settlement: Protecting Residents and Their Environment

2025-11-24

Environmental Defense Fund (EDF) joined PSE&G, New Jersey Ratepayer Counsel, and New Jersey Board of Public Utilities (BPU) staff in a settlement approved last week that protects New Jersey residents and our environment. EDF supports the settlement and applauds the BPU for approving it in full.

"New Jersey's gas customers win with this settlement," said Curt Stokes, Director and Senior Attorney at Environmental Defense Fund. "It significantly cuts costs for customers by scaling back PSE&G's originally proposed increases to infrastructure spending and removes a proposal to charge ratepayers for unproductive renewable natural gas and hydrogen projects."

A recent study, commissioned by EDF and conducted by the think tank Switchbox, shows that blending green hydrogen into New Jersey's natural gas system as proposed by PSE&G in its original filing would be far less efficient than directly electrifying homes and using efficient, affordable, and reliable heat pumps.

Read More

EDF, 24-11-25

https://www.edf.org/media/new-jersey-settlement-protecting-residents-and-their-environment

Risk management scope for triphenyl phosphate (TPHP) and tris(2-butoxethyl) phosphate (TBOEP)

2025-11-21

Summary of proposed risk management

This risk management scope outlines the risk management options under consideration for TPHP and TBOEP. It is proposed to conclude that these substances are harmful to human health under a human health risk characterization. The proposed risk management options under consideration for human health are being considered in addition to the risk management options under consideration to address the risks to the environment of the aryl organophosphates subgroup (which includes TPHP), as outlined in the November 2021 Risk Management Scope for TPHP, BPDP, BDMEPPP, IDDP, IPPP and TEP.

For the purposes of paragraph 77(1)(a) of the Canadian Environmental Protection Act, 1999 (CEPA), the Government of Canada proposes to recommend that TPHP and TBOEP be added to Part 2 of Schedule 1 to CEPAFootnote1. As a result, the Government of Canada is considering the following new risk management actions:

- Regulatory and/or non-regulatory actions to reduce dermal exposure to TPHP of adults from certain lubricants and greases
- Regulatory and/or non-regulatory actions to reduce prolonged dermal exposure to TPHP of people of all ages from products made with polymeric foams (such as certain mattresses and upholstered furniture)
- Regulatory and/or non-regulatory actions to reduce prolonged dermal exposure to TPHP of infants and children up to 13 years of age from the foam in certain infant and child restraint systems
- Regulatory and/or non-regulatory actions to reduce prolonged dermal exposure of people of all ages to TBOEP in products made with polymeric foams (such as certain mattresses and upholstered furniture)
- Regulatory and/or non-regulatory actions to reduce prolonged dermal exposure of infants and children up to 13 years of age to TBOEP in the foam of certain infant and child restraint systems

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The Government of Canada is also considering other risk management actions, as follows:

- Listing TPHP as a prohibited or restricted ingredient on the Cosmetic Ingredient HotlistFootnote2 to help reduce dermal exposure to TPHP of people 4 years of age and older from certain nail care products

To inform risk management decision-making, information on the following topics should be provided (ideally on or before January 21, 2026) to the contact details identified in section 8 of this document:

- Anticipated economic impacts if the import/export and/or use of TPHP and/or TBOEP are prohibited or restricted in Canada
- Ongoing or anticipated changes in use of the above flame retardants, whether in response to:
  Shifts to alternative substances (please provide commercial name), alternative systems and approaches
- Market forces
- Changes in performance-based flammability requirements and/or standards; and/or
- Other reasons (please provide information on these reasons)

Read More

Government of Canada, 21-11-25

https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/risk-management-scope-triphenyl-phosphate-tris-2-butoxethyl-phosphate.html

EUROPE

The Circulation Room – a reflection on ultra-fast fashion and sharing

2025-11-26

We live in a world where everything has to be fast. Cars, the internet, even reading—speed-reading courses are more popular than ever (not to mention one-minute fairy tales for children). But nothing moves faster than fashion. It seems that when it comes to getting dressed, people are constantly racing against time.

Once, fast fashion was the problem. Today, it's ultra-fast fashion—a beast of an entirely new scale. France, for instance, differentiates the two by

production speed: fast fashion brands release about 1,000 new items a day, while ultra-fast fashion companies push out up to 12,000.

The result? A dizzying flood of clothes that no one really needs.

The numbers tell a stark story. Every year, the global fashion industry produces between 100 and 150 billion garments, and around 120 million tons of those end up in landfills or are incinerated. We already have enough clothes on this planet to dress ourselves, our children, and our grandchildren, yet production keeps accelerating.

Behind this endless stream of cheap clothes lies an uncomfortable truth. The average price of clothing has plummeted over the past 30 years, while production has skyrocketed. Clothes are cheaper than ever. So cheap that we no longer think twice before buying, or before throwing them away. But the real price is paid elsewhere: in developing countries, where garment workers often earn far below a living wage and work under harsh, unsafe conditions.

Fashion is now one of the world's most polluting industries, responsible for about 10% of global carbon emissions. It consumes vast amounts of water, chemicals, and energy, and pollutes rivers and ecosystems in the process. Yet, we rarely think about who made our clothes—or what happened to them before they ended up on a hanger.

Read More

Zero Waste Europe, 26-11-25

https://zerowasteeurope.eu/2025/11/the-circulation-room-a-reflection-on-ultra-fast-fashion-and-sharing/

What you need to know about e-waste, and how communities across Europe are taking action

2025-11-26

E-waste is the EU's fastest-growing waste stream, rising by around 2% every year. In 2022, Europeans bought 14.4 million tonnes of electrical and electronic equipment, yet only 5 million tonnes of WEEE (Waste Electrical and Electronic Equipment) were officially collected, about 11.2 kg per person. Nearly half of all e-waste slips through formal systems, and only around 40% is properly recycled.

Read the factsheet about the overview of WEEE within the EU framework.

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Why e-waste matters

WEEE includes everything from fridges and TVs to laptops, routers, toys, and small household gadgets. These items contain hazardous substances that can contaminate soil, water, and air if improperly handled. At the same time, they hold valuable and critical raw materials essential to Europe's digital infrastructure, climate technologies, and green transition.

Recovering these materials through reuse, repair, and high-quality recycling reduces environmental impact and strengthens Europe's strategic autonomy.

Communities leading the way

Across Europe, people are showing that practical, community-based solutions already exist. The European Week for Waste Reduction (EWWR) brings together public authorities, NGOs, schools, businesses, and citizens to promote real-world actions that cut waste. This year's focus on e-waste highlights how local initiatives can deliver measurable impact.

Read More

Zero Waste Europe, 26-11-25

https://zerowasteeurope.eu/2025/11/what-you-need-to-know-about-e-waste-and-how-communities-across-europe-are-taking-action/

Spotlight: New report shines light on industry actors attempting to remove EU water protections

2025-11-24

A new report, "Industry's role in water resilience: How some lead – and others wreck", has lifted the lid on how little some of Europe's most powerful industry groups care about the rules that protect people and nature from one of the biggest threats of our time: pollution and destruction of nature. The findings reveal attempts by parts of the agriculture, energy, mining, and chemical sectors to weaken the EU's cornerstone water protection law, the Water Framework Directive (WFD), under the guise of "simplification" and "competitiveness."

Despite depending on clean and abundant water for their own operations, these lobbies are pressuring the European Commission (EC) to use the upcoming Environmental "Omnibus" Package – the EC's proposal to deregulate (rip up) environmental laws – to roll back fundamental WFD safeguards. Their demands include scrapping the "one-out, all-out"

principle, watering down the ban on destroying nature, and postponing the 2027 deadline to restore Europe's rivers, lakes, and aquifers to good health. All despite the fact that the WFD was given a clean bill of health, declared as "fit for purpose" by the Commission's own fitness check, only in 2019.

If granted, these changes would open the floodgates to further pollution and nature destruction, threatening not only ecosystems and wildlife, but also vital sources of drinking water – endangering the health of millions of people across Europe, while at the same time undermining the EU's new Water Resilience Strategy and Europe's climate goals.

The report shows how industrial agriculture seeks to dodge vitally needed pollution controls, extractive industries want freer permits for new mines, and energy giants are pushing to redefine pollution standards, all while claiming to act in the name of green growth. All in the name of short-term profits.

Read More

EEB, 24-11-25

https://eeb.org/en/spotlight-new-report-shines-light-on-industry-actors-attempting-to-remove-eu-water-protections/

Legislative and guidance proposals for the Control of Asbestos Regulations 2012

2025-11-10

The Health and Safety Executive (HSE) undertakes a wide range of regulatory functions fundamental to enabling a safe and healthy workplace. We are dedicated to protecting people and places and helping everyone lead safer and healthier lives. Our role goes beyond worker protection to include public assurance. We work to ensure people feel safe where they live, where they work and, in their environment.

Great Britain (GB) has one of the best workplace health and safety performances in the world and achieves some of the lowest rates of occupational injury and fatality in Europe.

HSE's work supports innovation, productivity and economic growth in GB and businesses that adopt effective, proportionate health and safety practices increase productivity and employee engagement. HSE's strategy - Protecting people and places: HSE strategy 2022 to 2032 – also commits HSE to enabling industry to reduce workplace ill health.

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This consultative document is issued by HSE in compliance with its duty to consult under section 50(3) of the Health and Safety at Work etc. Act 1974 and in line with the Government's Consultation Principles for consulting with stakeholders.

The consultation aims to seek stakeholders views on regulatory and non-regulatory proposals:

Regulatory

1. To amend the Control of Asbestos Regulations 2012 and associated guidance to ensure the independence and impartiality of roles in the four-stage clearance process to minimise the risk of exposure from asbestos to workers and building users after the removal of asbestos

Read More

HSE, 10-11-25

https://consultations.hse.gov.uk/hse/proposals-control-of-asbestos-regs-2012/

Revision of EU legislation on drug precursors: Implementation take-aways

2025-12-03

The main objective of European Union regulation of drug precursors is to strike a balance between preserving the legitimate interests of businesses that commercialise chemical substances for licit economic activities, and the need for controls to prevent their diversion to illicit narcotic drugs production. However, measures to control the trade in drug precursors only partially prevent their illicit use. Despite reforms to apply controls to new substances more rapidly, criminal networks have demonstrated their ability to circumvent the rules by using unscheduled (see below) and ever-emerging substances to further produce narcotic drugs and psychoactive substances. They also seize opportunities provided by new global trade modus operandi via postal or online platforms. The inclusion of substances submitted to strict control on a list is no longer sufficient; drug precursor regulations have become only one of the tools available to prevent, reduce and eventually end their misuse. The need to revise the drug precursors regulations as envisaged in the European Commission's 2025 work programme is not put into question; however, the revision needs to be understood and conceived within the broader policy framework on the fight against drugs trafficking and be supported by operational measures,

such as innovative technologies to detect drug precursors within the EU and across its borders. The Commission is expected to publish the new proposal on 3 December 2025.

Read More

European Parliament, 03-12-25

https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2025)774691

INTERNATIONAL

World's biggest chemicals group to exit PFAS 'forever chemicals'

2025-11-26

PRESS RELEASE: BASF will phase out PFAS by 2028. This decision signals a new trend among chemical giants to phase out "forever chemicals" amid mounting investor concerns over safety and the environment.

The world's largest chemicals group, BASF, will phase out PFAS by 2028, ChemSec can reveal, as it joins a raft of major companies turning their back on controversial "forever chemicals."

According to the ChemScore index, published yesterday, one-third of major chemicals manufacturers say they intend to exit highly persistent chemicals, the toxic group to which PFAS belong.

"Considering the need to maintain high safety and environmental standards, BASF calls for substituting the use of PFAS in industrial equipment," BASF said in a statement.

The German conglomerate, with sales of €65 billion last year, said it will phase out products (excluding crop protection) formulated with PFAS, opting instead to provide innovative alternatives to customers.

BASF says it adopted this position in May 2023. Although the company does not provide a clear exit date, its sustainability manual indicates the phase-out must take place within five years, or by 2028.

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Read More

Chemsec, 26-11-25

https://chemsec.org/worlds-biggest-chemicals-group-to-exit-pfas-forever-chemicals/

Global Environment Outlook 7 Launch

2025-12-05

The Global Environment Outlook is UNEP's flagship environmental assessment. GEO-7, the product of 287 multi-disciplinary scientists from 82 countries, is the most comprehensive scientific assessment of the global environment ever carried out. GEO-7, the product of 287 multi-disciplinary scientists from 82 countries, is the most comprehensive scientific environmental assessment ever carried out. It focuses on how to tackle the global environmental crises the world is currently facing. The report shows how investing in a stable climate and healthy nature can deliver higher GDP, fewer deaths, and less poverty. It assesses two main themes: the impacts of the interlinked global environmental crises of climate change, biodiversity loss and land degradation, and pollution and waste; and how these crises can be addressed through systems transformations. GEO-7 draws on a diversity of world views and knowledge from many different sources including the natural, social and behavioural sciences, modelling, economics, as well as Indigenous Knowledge and Local Knowledges

Read More

UNEP, 05-12-25

https://www.unep.org/events/publication-launch/global-environment-outlook-7-launch

REACH Update

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Video tutorials help navigate ECHA CHEM

2025-12-03

Have a look at the first two video tutorials on our new chemicals database ECHA CHEM.

These tutorials show how to navigate REACH registrations, search for analytical and ecotoxicological information in them and interpret key study data.

The first two videos are part of a series of short tutorials – more will come soon.

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ECHA, 03-12-25

Video tutorials help navigate ECHA CHEM

Janet's Corner

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tWho am I?

2025-12-19

I am a brilliant, white noble gas used in certain types of photography flashes and high-intensity lamps.

(Send in your answers and get a surprise Chemwatch merch from us for free)

I am a brilliant, white noble gas used in certain types of photography flashes and high-intensity lamps.
.

1,1,2-Trichloroethane

2025-12-19

USES [2,3]

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

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- Industry sources: The primary sources of 1,1,2-Trichloroethane emissions are the industries that manufacture it or use it in production. Some of the industries that use it in production are the chemical industry, rubber manufacturers, heavy equipment manufacturing, the timber products industry, the plastics and synthetics industries and laundries. These are emissions to the air unless there is a spill.
- Diffuse sources: Other possible emitters of 1,1,2-Trichloroethane are the electronics industry (solvent use) and manufacturers of fabricated metal parts.
- Natural sources: 1,1,2-Trichloroethane does not occur naturally in the environment.
- Transport sources: No mobile sources.
- Consumer products: Aerosol paint concentrates.

Routes of Exposure

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

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

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

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HEALTH EFFECTS [4]

Carcinogenicity

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

Other Effects

No information is available on the chronic effects of 1,1,2-trichloroethane in humans from inhalation or oral exposure. •Animal studies have not observed adverse effects from chronic inhalation exposure to 1,1,2-trichloroethane. Effects on the liver and immune system have been noted in chronic oral studies. EPA has not established a Reference Concentration (RfC) for 1,1,2-trichloroethane.

The California Environmental Protection Agency (CalEPA) has established a chronic reference exposure level of 0.4 milligrams per cubic metre (mg/m3) based on liver effects in rats.

The Reference Dose (RfD) for 1,1,2-trichloroethane is 0.004 milligrams per kilogram body weight per day (mg/kg/d) based on clinical serum chemistry in mice.

SAFETY

Personal Protective Equipment [5]

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

- Splash goggles;
- Lab coat;
- Gloves

Personal Protection in Case of a Large Spill:

- Splash goggles;
- Full suit;
- Boots;

- Gloves;
- Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

REGULATION

United States

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

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

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

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

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

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

'AI advisor' helps self-driving labs share control in creation of next-generation materials

2025-12-18

"Self-driving" or "autonomous" labs are an emerging technology in which artificial intelligence guides the discovery process, helping design experiments or perfecting decision strategies.

While these labs have generated heated debate about whether humans or machines should lead scientific research, a new paper from Argonne National Laboratory and the University of Chicago Pritzker School of Molecular Engineering (UChicago PME) has proposed a novel answer: Both.

In the paper published in Nature Chemical Engineering, the team led by UChicago PME Asst. Prof. Jie Xu, who has a joint appointment at Argonne, outlined an "AI advisor" model that helps humans and machines share the driver's seat in self-driving labs.

Inspired by the software used to help investors trade stocks, the model leverages AI's data-processing prowess but keeps decisions in the hands of experienced researchers accustomed to making real-time choices using limited datasets.

"The advisor will perform real-time data analysis and monitor the progress of the self-driving lab's autonomous discovery journey. If the advisor observes a decline in performance, the advisor is going to prompt the human researchers to see if they want to switch the strategy, refine the design space or so on," said Xu. "Compared to the traditional self-driving lab where we stick with one decision strategy from the beginning to the end, this makes the entire decision workflow adaptive and boosts the performance significantly."

Co-corresponding author Henry Chan, a staff scientist at the Nanoscience and Technology division at Argonne, said the goal is not to put either AI or humans in charge, but to have each focus on what they do best.

"People have been focusing a lot on self-improving AI—AI that can modify its own algorithm, generate its own data set, retrain itself and all that," Chan said. "But here we're taking a cooperative approach where humans can play a role in the process also. We want to facilitate collaboration between humans and AI to achieve co-discovery."

Putting the AI advisor to work

The team applied the advisor model to work on an electronic materials challenge, using the self-driving lab Polybot, located in Argonne's Center for Nanoscale Materials, to study and design an electronic material called a mixed ion-electron conducting polymer (MIECP).

The MIECP created through this merger of machine and human intelligence showed a 150% increase in mixed conducting performance over MIECPs created through the previous cutting-edge technique.

It also helped identify two factors key to increasing this volumetric capacitance—a larger crystalline lamellar spacing and higher specific surface area. This advance in pure science will help future researchers better design MIECP, said UChicago PME Assoc. Prof. Sihong Wang, also a co-corresponding author on the new paper.

"For material science research, there are two intercorrelated goals," Wang said. "One is to improve the material's performance or develop new performance. But to enable that, you need the second goal: a deep understanding of how different material design strategies, parameters and processing conditions will influence that performance. By making the entire space of the structure variation much larger, this AI model has helped to achieve two goals at the same time."

"While AI is excellent at this form of data analysis, it falters at decision-making when there are few data points to guide it," Xu said. This is where experienced human researchers excel.

"The methodology that we use for this study offers a generalizable framework that can be adopted by other self-driving labs," Xu said. "But basically, we cannot promote humans in the lengthy design, fabrication and test-analysis loop. We promote human–machine collaboration to boost discovery together."

The team next looks to improve the communication not from the AI, but to it, helping humans and software better advance science together.

"Currently, the interaction is mostly one-way. Information is coming from the AI advisor, then humans take optional actions," Chan said. "In the future, we want a tighter integration between AI and humans, where

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the AI can learn from human actions and modify the way it thinks in subsequent iterations, modeling the way of human decision-making."

Phys Org, 18 December 2025

https://phys.org

How Microplastics Trigger Inflammation in the Brain

2025-12-08

Microplastics could be fuelling neurodegenerative diseases like Alzheimer's and Parkinson's, with a new study highlighting five ways microplastics can trigger inflammation and damage in the brain.

More than 57 million people live with dementia, and cases of Alzheimer's and Parkinson's are projected to rise sharply. The possibility that microplastics could aggravate or accelerate these brain diseases is a major public health concern.

Pharmaceutical scientist Associate Professor Kamal Dua, from the University of Technology Sydney, said it is estimated that adults are consuming 250 grams of microplastics every year – enough to cover a dinner plate.

"We ingest microplastics from a wide range of sources including contaminated seafood, salt, processed foods, tea bags, plastic chopping boards, drinks in plastic bottles and food grown in contaminated soil, as well as plastic fibres from carpets, dust and synthetic clothing."

"Common plastics include polyethylene, polypropylene, polystyrene and polyethylene terephthalate or PET. The majority of these microplastics are cleared from our bodies, however studies show they do accumulate in our organs, including our brains."

The systematic review, recently published in Molecular and Cellular Biochemistry, was an international collaboration led by researchers from the University of Technology Sydney and Auburn University in the US.

The researchers highlighted five main pathways through which microplastics can cause harm to the brain, including triggering immune cell activity, generating oxidative stress, disrupting the blood–brain barrier, impairing mitochondria and damaging neurons.

"Microplastics actually weaken the blood–brain barrier, making it leaky. Once that happens, immune cells and inflammatory molecules are

activated, which then causes even more damage to the barrier's cells," said Associate Professor Dua.

"The body treats microplastics as foreign intruders, which prompts the brain's immune cells to attack them. When the brain is stressed by factors like toxins or environmental pollutants this also causes oxidative stress," he said.

Microplastics cause oxidative stress in two main ways: they increase the amount of "reactive oxygen species" or unstable molecules that can damage cells, and they weaken the body's antioxidant systems, which normally help keep those molecules in check.

"Microplastics also interfere with the way mitochondria produce energy, reducing the supply of ATP, or adenosine triphosphate, which is the fuel cells need to function. This energy shortfall weakens neuron activity and can ultimately damage brain cells," said Associate Professor Dua.

"All these pathways interact with each other to increase damage in the brain."

The paper also explores specific ways in which microplastics could contribute to Alzheimer's, including triggering increased buildup of beta-amyloid and tau; and in Parkinson's through aggregation of α-Synuclein and damage to dopaminergic neurons.

First author UTS Master of Pharmacy student Alexander Chi Wang Siu is a currently working in the lab of Professor Murali Dhanasekaran at Auburn University, in collaboration with Associate Professor Dua, Dr Keshav Raj Paudel and Previous UTS research has examined how microplastics are inhaled and where they are deposited in the lungs. Dr Paudel, a visiting scholar in the UTS Faculty of Engineering, is also currently investigating the impact of microplastic inhalation on lung health.

While evidence suggests microplastics could worsen diseases like Alzheimer's and Parkinson's, the authors emphasise that more research is needed to prove a direct link. However, they recommend taking steps to reduce microplastic exposure.

"We need to change our habits and use less plastic. Steer clear of plastic containers and plastic cutting boards, don't use the dryer, choose natural fibres instead of synthetic ones and eat less processed and packaged foods," said Dr Paudel.

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The researchers hope the current findings will help shape environmental policies to cut plastic production, improve waste management and reduce long-term public health risks posed by this ubiquitous environmental pollutant. Distinguished Professor Brian Oliver from UTS, to better understand how microplastics affect brain cell function.

Technology Networks, 8 December 2025

https://technologynetworks.com

Physicists Propose First-Ever Experiment To Manipulate Gravitational Waves

2025-12-18

A new concept for energy transfer between gravitational waves and light.

When massive cosmic objects such as black holes merge or neutron stars crash into one another, they can produce gravitational waves. These ripples move through the universe at the speed of light and create extremely small changes in the structure of space-time. Their existence was first predicted by Albert Einstein, and scientists confirmed them experimentally for the first time in 2015.

Building on this discovery, Prof. Ralf Schützhold, a theoretical physicist at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR), is proposing a bold new step.

Schützhold has developed a concept for an experiment that would go beyond detecting gravitational waves and instead allow researchers to influence them. The proposal, published in the journal Physical Review Letters, could also help clarify whether gravity follows quantum rules, a question that remains unresolved in modern physics.

Manipulating Gravitational Waves With Light

"Gravity affects everything, including light," says Schützhold. And this interaction also occurs when gravitational waves and light waves meet. Schützhold's idea is to transfer tiny packets of energy from a light wave to a gravitational wave. By doing so, the energy of the light wave is reduced slightly, and the energy of the gravitational wave is increased by the same amount.

The transferred energy corresponds to one or more gravitons, the hypothetical particles that are thought to carry the force of gravity in quantum theories, but which have not yet been directly observed.

"It would make the gravitational wave a tiny bit more intensive," explains the physicist. The light wave, on the other hand, loses exactly the same amount of energy which leads to a minute change in the light wave's frequency.

"The process can work the other way around, too," Schützhold continues. In this case, the gravitational wave dispenses an energy package to the light wave. It should be possible to measure both effects, that is, the stimulated emission and absorption of gravitons, albeit with considerable experimental effort.

An Experiment on an Extreme Scale

Schützhold has calculated the huge dimensions of such an experiment: potentially, laser pulses in the visible or near-infrared spectral range could be reflected back and forth between two mirrors up to a million times. In a set-up about a kilometer long, this would produce an optical path length of around one million kilometers. Such an order of magnitude is sufficient to conduct the desired measurement of the energy exchange caused by the absorption and emission of gravitons when light and a gravitational wave meet.

However, the change in the frequency of the light wave caused by the absorption or release of the energy of one or more gravitons in interaction with the gravitational wave is extremely small. Nevertheless, by using a cleverly constructed interferometer it should be possible to demonstrate these changes in frequency.

In the process, two light waves experience different changes in frequency – depending on whether they absorb or emit gravitons. After this interaction and passing along the optical path length, they overlap again and generate an interference pattern. From this, it is possible to infer the frequency change that has occurred and thus the transfer of gravitons.

Probing the Quantum Nature of Gravity

"It can take several decades from initial idea to experiment," says Schützhold. But perhaps it might happen sooner in this case, as the LIGO Observatory – acronym for the Laser Interferometer Gravitational-Wave Observatory – that is dedicated to detecting gravitational waves,

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shows strong similarities. LIGO consists of two L-shaped vacuum tubes approximately four kilometers long.

A beam splitter divides a laser beam onto both arms of the detector. As they pass through, incoming gravitational waves minimally distort space-time, which causes changes of a few attometers (10-18 meters) in the originally equal length of the two arms. This tiny change in length alters the interference pattern of the laser light, generating a detectable signal.

In an interferometer tailored to Schützhold's idea, it could be possible not only to observe gravitational waves but also to manipulate them for the first time by stimulated emission and absorption of gravitons. According to Schützhold, light pulses whose photons are entangled, that is, quantum mechanically coupled, could significantly increase the sensitivity of the interferometer further.

"Then we could even draw inferences about the quantum state of the gravitational field itself," says Schützhold. While this would not be direct proof of the hypothetical graviton, which is the subject of intense debate among physicists, it would at least be a strong indication of its existence.

After all, if the light waves did not exhibit the predicted interference effects when interacting with gravitational waves, the current theory based on gravitons would be disproved. It is thus hardly surprising that Schützhold's concept for the manipulation of gravitational waves is meeting with great interest among his colleagues.

Sci Tech Daily, 18 December 2025

https://scitechdaily.com

Rare earth elements: Of peptides and the origins of life

2025-12-18

The group of rare earth elements (REEs) comprises a total of 17 elements, all of which possess similar chemical properties. In addition to the two lightest elements, scandium and yttrium, the group also includes lanthanum, cerium and neodymium, as well as the radioactive promethium.

The name of this group of elements is misleading as they are not rare on Earth; rather, their deposits are distributed very unevenly worldwide, which makes them important in global political terms. REEs are needed for many high-tech applications—from smartphones and magnets (for example, for wind turbines), to catalysts and optical components.

How organisms absorb rare earth elements

The Bioinorganic Chemistry group of Professor Dr. Lena Daumann, is examining how organisms can absorb rare earth elements. The aim is to potentially use these processes technically to extract the elements or recycle them from old devices.

In their study "Reversing Lanmodulin's Metal-Binding Sequence in Short Peptides Surprisingly Increases the Lanthanide Affinity," published in Angewandte Chemie International Edition, Daumann's team—in collaboration with the Helmholtz Center Dresden-Rossendorf (HZDR)—is focusing on short-chain proteins (peptides) inspired by the REE-binding protein lanmodulin found in the bacterium Methylorubrum extorquens AM1. The new peptides synthesized in Düsseldorf display a strong binding affinity for this group of elements.

Dr. Sophie M. Gutenthaler-Tietze, lead author of the study and postdoc at Daumann's Institute, says, "The development of these short peptides actually originates from a synthesis error. We accidentally reversed the sequence of amino acids in the peptide compared with those in the natural protein lanmodulin. Interestingly, the peptides created in this way display an affinity for rare earth elements, which is one order of magnitude higher than their natural counterparts."

Together with the colleagues from Dresden-Rossendorf, the researchers identified structural motifs, which are responsible for the high level of affinity. Daumann says, "On this basis, we further optimized the affinity and were able to push it into the low nanomolar range. The examined peptides form an ideal basis for developing sustainable, bio-inspired recycling methods for rare earth elements. By reclaiming resources that have already been used, we are not only reducing the burden on the environment, but also increasing our raw material independence."

Rare earth elements and early life

The second study, also published in Angewandte Chemie International Edition, "Influence of Rare Earth Elements on Prebiotic Reaction Networks Resembling the Biologically Relevant Krebs Cycle," focuses on an entirely different aspect of rare earth elements, namely their role in the emergence of the earliest life on Earth.

More than 3.5 billion years ago on the abiotic Earth, small organic building blocks began to react with each other under the right conditions. They formed increasingly complex structures, the precursors of biological

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macromolecules. It is highly likely that metals such as iron played a key role in this process as catalysts. To date, however, there has hardly been any consideration of the possibility that rare earth elements might also have been important in this process.

Lead author Dr. Jonathan Gutenthaler-Tietze states, "For the first time, we systematically examined whether these elements facilitate reactions in a prebiotic scenario. And rare earth elements can in fact moderate key chemical reactions. Starting with glyoxylate and pyruvate, two simple organic acids seen as potential starting materials for early life, we identified seven of eleven intermediates of the biological 'Krebs cycle' in the presence of the rare earth elements." The Krebs cycle is a central component of the energy metabolism of all living creatures. The reactions formed a complex network with numerous connections.

Daumann says, "The ionic radii of rare earth elements are key to their reactivity. We also noted that even very small concentrations are already sufficient to have a significant influence on the reaction network. The results thus bring a previously underestimated group of elements into the focus of prebiotic research."

Phys Org, 18 December 2025

https://phys.org

Scientists Identify Promising New Magnetic Material for the AI Era

2025-12-18

A newly validated magnetic state could open a path toward ultra-fast, high-density memory for future AI and data-center technologies.

A collaborative team of researchers from NIMS, the University of Tokyo, Kyoto Institute of Technology, and Tohoku University has shown that thin films of ruthenium dioxide (RuO_2) display altermagnetism, a key characteristic of what is now considered the third basic category of magnetic materials.

Materials with altermagnetic properties could address key drawbacks of today's magnetic random access memory, which relies on conventional ferromagnets. Because of this potential, they are drawing interest as candidates for future memory technologies that aim to deliver much higher speed and data density.

The study not only identifies RuO2 as a promising material for these applications but also points to a way to further improve its performance by carefully controlling the orientation of its crystal structure. These results were recently reported in Nature Communications.

Ruthenium dioxide (RuO2) has increasingly been studied as a possible platform for altermagnetism, which has been proposed as a third fundamental form of magnetism.

Traditional ferromagnetic materials used in memory devices make it relatively easy to write data using external magnetic fields. However, they are vulnerable to interference from unwanted stray fields, which can cause errors and place limits on how densely information can be stored.

Limitations of Existing Magnetic Materials

Antiferromagnetic materials, on the other hand, are robust against such external disturbances. However, because their atomic-level spins cancel each other out, it is difficult to electrically read information from them.

This has driven demand for magnetic materials that combine resistance to external disturbances with compatibility with electrical readout, and ideally also allow rewritability.

However, experimental results concerning altermagnetism in RuO_2 have been inconsistent worldwide, hindering a clear understanding of its fundamental nature. Moreover, the lack of high-quality thin-film samples with uniform crystallographic orientation has prevented conclusive experimental verification.

The joint research team successfully fabricated single-orientation (single-variant) RuO2 thin films with aligned crystallographic axes on sapphire substrates. They clarified the mechanism by which crystallographic orientation is determined through optimal substrate selection and fine-tuning of growth conditions.

Experimental Verification of Altermagnetism

Using X-ray magnetic linear dichroism, the team identified the spin arrangement and magnetic ordering in which the net magnetization (N–S poles) cancels out. Furthermore, they observed spin-split magnetoresistance—a phenomenon in which electrical resistance varies depending on spin orientation—thereby electrically verifying the spin-splitting electronic structure.

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The results of the X-ray magnetic linear dichorism were consistent with first-principles calculations on the magneto-crystalline anisotropy, demonstrating that the RuO2 thin films exhibit altermagnetism.

This finding strongly supports the potential of RuO2 thin films as promising materials for next-generation high-speed, high-density memory devices.

Building on these results, the research team aims to develop next-generation high-speed, high-density magnetic memory devices utilizing RuO_2 thin films.

Such devices are expected to contribute to more energy-efficient information processing by leveraging the inherently high-speed and high-density characteristics of altermagnetism.

Furthermore, the synchrotron-based magnetic analysis technique established in this study can be applied to the exploration of other altermagnetic materials and the development of spintronic devices.

Sci Tech Daily, 18 December 2025

https://scitechdaily.com

"Self-densified" wood could give metal a run for its money

2025-03-25

While sustainably-grown wood can be an economical and eco-friendly building material, its relatively low tensile strength limits its potential applications. That could soon change, however, thanks to a new self-densifying technique for creating super-strong wood.

Individual wood fibers are made up mainly of cellulose, along with a binder material known as lignin. This mixture forms the wall of what is essentially a long hollow tube – the fiber – which runs lengthwise within the larger piece of wood. The hollow space inside the tube is called the lumen, and it is what limits wood's strength.

A team from China's Nanjing University recently set out to address that shortcoming, by developing the new process.

It begins by boiling a block of wood in a mixture of sodium hydroxide (lye) and sodium sulfite, removing some of the lignin. That block is then immersed in a heated blend of lithium chloride salt and a solvent known

as dimethylacetamide. This causes the cellulose (and remaining lignin) to swell, expanding inwards to fill the lumen.

In a final step, the processed wood is left to air-dry at room temperature for 10 hours. As it does so, it uniformly shrinks inwards from all sides, but maintains its original length.

The resulting material is claimed to exhibit "ultra-high" tensile strength, flexural strength, and impact toughness – much more so than natural wood. It even surpasses wood which has been compressed by traditional methods, in which the fibers are just mechanically flattened in one direction.

And unlike other methods of uniformly densifying wood, it doesn't require an energy-intensive hot-pressing process.

It is hoped that once the technology is developed further, the self-densified wood could be used as an alternative to traditional metals in building construction and other possible applications.

A paper on the research, which was led by Dafang Huang and Jie Li, was recently published in the Journal of Bioresources and Bioproducts.

New Atlas, 3 March 2025

https://newatlas.com

Organic materials conduct ions in solids as easily as in liquids thanks to flexible sidechains

2025-12-18

Normally, when liquids solidify, their molecules become locked in place, making it much harder for ions to move and leading to a steep decrease in ionic conductivity. Now, scientists have synthesized a new class of materials, called state-independent electrolytes (SIEs), that break that rule.

The paper is published in the journal Science.

How the new electrolytes work

The team have achieved this result by designing a new class of organic molecular ions with special physical and electronic properties. Each molecule has a flat, disk-shaped center surrounded by long flexible sidechains—like a wheel with soft bristles.

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Positive charge is spread out evenly across the molecule by the movement of electrons, which prevents it from tightly binding with its negatively charged partner. This allows the negative ions to move freely, flowing through the side-chains (the "soft bristles").

Then, in the solid state, these organic ions naturally stack on top of each other, forming long rigid columns surrounded by many flexible arms: much like static rollers in a car-wash. Despite forming an ordered structure, the flexible side chains still create enough space for the negative ions to continue moving as freely as they would in a liquid.

The result: a dynamic ordered structure that allows the negatively charged ions to move through just as easily in the solid state as in the liquid form, with no sharp decrease in ionic conductivity.

Researchers react to the findings

Lead author Professor Paul McGonigal (University of Oxford) says, "We designed our materials hoping that ions would move through the flexible, self-assembled network in an interesting way. When we tested them, we were amazed to find that the behavior is unchanged across liquid, liquid-crystal, and solid phases. It was a really spectacular result—and we were happy to find it can be repeated with a few different types of ions."

Ph.D. student Juliet Barclay, first author on the study, says, "As a Ph.D. student, it's incredibly rewarding to discover something that changes how we think materials can work. We've shown that organic materials can be engineered so that the movement of ions doesn't 'freeze out' when the material solidifies. This opens new possibilities for safer, lightweight solid-state devices that work efficiently over wide temperature ranges."

Potential applications and next steps

This work is a collaboration between scientists at the Universities of Oxford, York, Leeds and Durham, with partners in Portugal, Germany, and the Czech Republic.

The discovery could lead to new classes of flexible and safe solid electrolytes. One potential use case could be adding the electrolyte into a device as a liquid at a slightly elevated temperature, allowing it to make good contact with the electrodes, before cooling to ambient temperature and using it in a safe solid form without losing ionic conductivity.

The resulting solid electrolytes have potential applications in batteries, sensors, and electrochromic devices, where organic solids are generally

advantageous over inorganic materials because of their lightweight and flexible physical properties, and the potential to source them renewably.

The research team at Oxford are now working to increase the conductivity and versatility of the materials, as well as using them in electronic devices for computing.

Phys Org, 18 December 2025

https://phys.org

Biodegradable Plates Could Transfer Gluten Into Some Foods

2025-12-17

Some biodegradable tableware is made with wheat straw or bran, ingredients that may contain gluten. Researchers tested commercially available biodegradable items, reporting the initial results in ACS' Journal of Agricultural and Food Chemistry. One plate contained gluten and transferred the allergen into some foods and drinks at levels above gluten-free thresholds. The researchers say that because these products don't require allergen labels, they could pose a health risk for people who need to avoid gluten.

Biodegradable tableware generally incorporates natural ingredients: fibers from bamboo; sugars from algae; and proteins from milk, eggs, soybeans or wheat. The transfer of allergens from these disposable dishes, cups and straws to foods and drinks isn't well understood. If a trace of gluten is eaten by someone who has celiac disease or a gluten sensitivity, it could trigger immune reactions, digestive distress or other adverse health outcomes. So, Ángela Ruiz-Carnicer, Isabel Comino and colleagues assessed several biodegradable items for the presence of gluten and whether the allergenic protein transferred to solid and liquid foods under realistic conditions.

The researchers first tested eight separate items, including dishes, cups and straws, that were labeled as biodegradable and made with wheat by-products or other potential gluten-containing materials. Only one of the items — a wheat-containing plate — had detectable gluten.

In 30-minute experiments, gluten-free foods were placed on the different tableware items at room temperature. The foods' gluten contents were measured and compared against the gluten-free (less than 20 ppm) and low-gluten (less than 100 ppm) regulatory thresholds set by the European

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Union and the U.S. Food and Drug Administration. Only the gluten-containing plate passed protein into omelet, rice, milk and vegetable cream samples. Significantly less gluten transferred into the solid foods than into the liquids:

- Rice: up to 17 ppm, below the gluten-free threshold.
- Omelet: up to 30 ppm, below the low-gluten threshold.
- Milk: up to 240 ppm, over the low-gluten threshold.
- Vegetable cream: up to 2,100 ppm, over the low-gluten threshold.

In some cases, microwaving foods on the dish reduced gluten contamination compared to room temperature samples, and the researchers hypothesize it is because heat denatures the protein and disrupts its transfer into foods.

The researchers urge mandatory gluten labeling for materials that contact food. They say that further work is needed to check whether biodegradable tableware can cross-contaminate food with other allergens (e.g., milk, soy and nut proteins). In the meantime, the team encourages consumers to check the components of their biodegradable tableware to prevent unexpected gluten exposure.

Technology Networks, 17 December 2025

https://technologynetworks.com

Reprieve for Grangemouth ethylene

2025-12-19

The UK government has agreed a £150 million support package for the Grangemouth industrial complex in Scotland. The site houses the UK's last remaining ethylene production plant, following ExxonMobil's decision in November to close the Fife Ethylene plant in nearby Mossmorran in early 2026, and Sabic's decision earlier in the year not to re-start its Olefins 6 cracker in Wilton.

The deal includes £25 million investment from plant owner Ineos, £75 million in financing from NatWest bank (underwritten by the government) and £50 million in government grants, according to BBC reporting. Ineos has agreed assurances that the funding can only be used to improve the site (rather than subsidise its everyday running) and give the government rights to a share in future profits.

Even before this year's closures, the UK imported over $1.5 billion-worth of ethylene a year, predominantly from Czechia, according to World Bank

trade data. Ineos has already closed the oil refinery on the Grangemouth site, choosing instead to ship shale gas-derived ethane from the US to feed its ethylene production. This means that all of the UK's ethylene supplies now effectively rely, to some extent, on imports.

The UK's plastics processors already consume around double the volume of plastics raw materials – including ethylene – produced domestically, with the shortfall coming from imports. At the same time, plastics products are one of the UK's most significant exports, worth almost £12 billion in 2024. The economic significance of this industry is part of the reason why the government has stepped in to support Grangemouth.

As Sky News economics editor Ed Conway points out, ethylene is a strategically important commodity, because it is the starting point for manufacturing all kinds of everyday items. Losing domestic ethylene supply would not only make the UK's plastics industry more vulnerable to international influences, it could trigger a domino effect throughout the UK's chemicals sector, threatening hundreds of thousands of jobs and critical industrial infrastructure.

However, it is far from clear how long the government's investment will keep the wolves from Ineos's door in Grangemouth. Optimistically, it is possible that the intended upgrades, combined with the government's strategic promises to lower industrial energy costs and introduce carbon emissions taxation on imports could tip the balance back in favour of domestic industry. In the meantime, the situation will remain distinctly precarious.

Chemistry World, 17 December 2025

https://chemistryworld.com

Dark Chocolate Compound Linked to Slower Biological Aging

2025-12-16

The idea that "you are what you eat" is gaining new meaning as researchers explore how diet shapes biological aging.

In a study led by researchers at King's College London, higher blood levels of theobromine, a compound found in cocoa, were associated with slower biological aging in two large European population studies.

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What is biological aging?

Aging is not just about the number of years lived; people of the same chronological age can differ widely in health, disease risk and survival. This has led researchers to focus on biological aging – a measure of how quickly the body's cells and tissues decline over time.

One way to estimate this is by using DNA-based markers in blood. These "epigenetic clocks" track chemical tags on DNA that change as we age.

Diet is one of the most studied factors that may shape biological aging. Research has linked overall diet quality, calorie restriction and certain nutrients to slower changes in these DNA markers. One popular area of study includes plant-derived compounds, such as cocoa and coffee. Consumption of these has been linked to lower rates of cardiovascular disease and death. However, these foods contain many compounds, and it has been difficult to pinpoint which ones might matter for aging.

Theobromine is a naturally occurring compound found in high amounts in cocoa and dark chocolate. It belongs to the same chemical family as caffeine but has different effects in the body. Studies in worms and observational work in humans have hinted at health benefits, including longer lifespan. However, there has been no clear evidence that links theobromine to molecular markers of aging in people, separate from caffeine and other cocoa components.

The new study aimed to investigate whether blood levels of theobromine are linked to slower biological aging in humans, and whether this link is specific to theobromine.

Theobromine levels and biological aging

The team analyzed data from two large European cohorts: the TwinsUK study, which included 509 adult women, and the German KORA cohort, used to replicate the findings in 1,160 men and women.

Instead of relying on diet questionnaires, the team measured theobromine directly in blood samples using a mass spectrometry method that captures a wide range of small molecules in serum.

To estimate biological aging, the researchers focused on two DNA-based measures from blood. The first was GrimAge acceleration, a marker strongly linked to the risk of death. The second estimated telomere length, a feature of chromosomes that shortens with age. Other aging clocks were also examined but showed less consistent patterns.

The analysis accounted for age, body mass index, blood cell types and family relationships in the twin cohort. The team also ran multiple checks to rule out confounding, including adjusting for caffeine and related compounds, and using statistical methods designed to deal with closely related variables. The main findings were then tested in the KORA cohort, where blood and DNA samples were taken at the same time.

Across both cohorts, higher levels of theobromine were linked to slower biological aging. The association was strongest for GrimAge acceleration and weaker, but still present, for the telomere-based measure.

No similar links were seen for caffeine or other coffee-related compounds.

A stronger association also appeared in smokers, although this subgroup was small.

What the findings mean for aging research

"Our study finds links between a key component of dark chocolate and staying younger for longer," said senior author Dr. Jordana Bell, a professor in epigenomics at King's College London.

"While we're not saying that people should eat more dark chocolate, this research can help us understand how everyday foods may hold clues to healthier, longer lives," she added.

However, the aging measures used are only indications and are not direct readouts of aging or lifespan. It is also possible that theobromine reflects intake of other cocoa compounds, such as flavanols, which were not directly measured.

"This study identifies another molecular mechanism through which naturally occurring compounds in cocoa may support health. While more research is needed, the findings from this study highlight the value of population-level analyses in aging and genetics," said co-author Dr. Ricardo Costeira, a postdoctoral research associate at King's College London.

Controlled trials that isolate theobromine intake would help test causality, and laboratory studies could clarify how theobromine interacts with gene regulation.

"This is a very exciting finding, and the next important questions are what is behind this association and how can we explore the interactions between dietary metabolites and our epigenome further? This approach could lead us to important discoveries towards aging, and beyond, in

Bird-of-Paradise Inspires Darkest Fabric Ever Made

2025-12-03

The color "ultrablack" – defined as reflecting less than 0.5% of the light that hits it – has a variety of uses, including in cameras, solar panels and telescopes, but it's difficult to produce and can appear less black when viewed at an angle. Now, a Cornell lab has devised a simple method for making the elusive color.

Taking cues from nature – in particular the striking black of the magnificent riflebird – researchers in the Responsive Apparel Design (RAD) Lab, in the College of Human Ecology (CHE), dyed a white merino wool knit fabric with polydopamine, followed by etching of the material in a plasma chamber to create nanofibrils – spiky nanoscale growths. These features were made to mimic the light-trapping capabilities found on the riflebird's ultrablack feathers, which absorb most of the light that hits them.

The researchers' two-step approach produced the darkest fabric currently reported; it's also easy to manufacture, scalable, wearable and not angle-dependent. The researchers have applied for patent protection with the Cornell Center for Technology Licensing (CTL) and hope to form a company around their process, which can be used on natural materials, including wool, silk and cotton.

"From a design perspective, I think it's exciting because a lot of the ultrablack that exists isn't really as wearable as ours. And it stays ultrablack even from wider angles," said Larissa Shepherd, M.S. '13, Ph.D. '17, assistant professor in the Department of Human Centered Design (CHE).

Shepherd, the RAD Lab's director, is senior author of "Ultrablack Wool Textiles Inspired by Hierarchical Avian Structure," which published Nov. 26 in Nature Communications. Shepherd's co-authors are doctoral students and RAD Lab members Hansadi Jayamaha and Kyuin Park, M.S. '23.

Their work included analysis of feathers from the riflebird, a member of the bird-of-paradise family found in New Guinea and Australia. Shepherd and her team obtained riflebird feathers from the Cornell Lab of Ornithology with the help of Mary M. Ferraro, bird collections manager, and Vanya Rohwer, curator of birds and mammals.

The riflebird's striking black plumage comes from melanin pigment combined with tightly bunched barbules that serve to deflect light inward,

absorbing nearly all of it. This renders the bird extraordinarily black, but only when viewed straight on; at an angle, its plumage appears shiny.

This same coloration is evident in other creatures, including fish and butterflies. Shepherd said her group's choice of polydopamine for their dye was intentional.

"Polydopamine is a synthetic melanin, and melanin is what these creatures have," she said. "And the riflebird has these really interesting hierarchical structures, the barbules, along with the melanin. So we wanted to combine those aspects in a textile."

It wasn't enough to simply coat the surface of the wool: The researchers had to have the polydopamine penetrate into the fibers of the fabric, so every bit of it became black. That's because the plasma etching process removes some surface material of the outermost fibers, leaving behind spiky nanofibrils, which are a key component.

"The light basically bounces back and forth between the fibrils, instead of reflecting back out – that's what creates the ultrablack effect," Jayamaha said.

Analysis revealed that the group's fabric had an average total reflectance of 0.13%, making it the darkest fabric yet reported. And it remained ultrablack across a 120-degree angular span, meaning it appears the same at up to a 60-degree angle either side or straight on, superior to currently available commercial materials.

According to Park, their ultrablack fabric has potential in many solar thermal applications, converting and utilizing absorbed light into thermal energy. "We could actually use the ultrablack fabric for thermo-regulating camouflage," he said.

Last fall, Zoe Alvarez '25, a fashion design management major (CHE), created a black strapless dress inspired by the riflebird that incorporated as its centerpiece ultrablack material with a splash of iridescent blue. Images of the dress were used to confirm ultrablack's true "blackness": When the image's contrast, hue, vibrance or brightness were adjusted, all the other colors changed, but ultrablack remained the same.

Shepherd said her team has applied for provisional patent protection through CTL and is looking to apply to its Ignite Innovation Acceleration program to push their idea closer to market.

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Analysis of the material was conducted at the Cornell Center for Materials Research and Human Centered Design shared instrumentation facility.

Technology Networks, 3 December 2025

https://technologynetworks.com

Synthetic chemicals in food system creating health burden of $2.2tn a year, report finds

2025-12-10

Scientists have issued an urgent warning that some of the synthetic chemicals that help underpin the current food system are driving increased rates of cancer, neurodevelopmental conditions and infertility, while degrading the foundations of global agriculture.

The health burden from phthalates, bisphenols, pesticides and Pfas "forever chemicals" amounts to up to $2.2tn a year – roughly as much as the profits of the world's 100 largest publicly listed companies, according to the report published on Wednesday.

Most ecosystem damage remains unpriced, they say, but even a narrow accounting of ecological impacts, taking into account agricultural losses and meeting water safety standards for Pfas and pesticides, implies a further cost of $640bn. There are also potential consequences for human demographics, with the report concluding that if exposure to endocrine disruptors such as bisphenols and phthalates persists at current rates, there could be between 200 million and 700 million fewer births between 2025 and 2100.

The report is the work of dozens of scientists from organisations including the Institute of Preventive Health, the Center for Environmental Health, Chemsec, and various universities in the US and UK, including the University of Sussex and Duke University. It was led by a core team from Systemiq, a company that invests in enterprises aimed at fulfilling the UN sustainable development goals and the Paris agreement on climate change.

The authors said they had focused on the four chemical types examined because "they are among the most prevalent and best studied worldwide, with robust evidence of harm to human and ecological health".

One of the team, Philip Landrigan, a paediatrician and professor of global public health at Boston College, called the report a "wake-up call". He said: "The world really has to wake up and do something about chemical

pollution. I would argue that the problem of chemical pollution is every bit as serious as the problem with climate change."

Human and ecosystem exposure to synthetic chemicals has surged since the end of the second world war, with chemical production increasing by more than 200 times since the 1950s and more than 350,000 synthetic chemicals currently on the global market.

Three years ago, researchers from the Stockholm Resilience Centre (SRC) concluded that chemical pollution had crossed a "planetary boundary", the point at which human-made changes to the Earth push it outside the stable environment of the past 10,000 years, the period in which modern human civilisation has developed.

Unlike with pharmaceuticals, there are few safeguards to test for the safety of industrial chemicals before they are put into use, and little monitoring of their effects once they are. Some have been found to be disastrously toxic to humans, animals and ecosystems, leaving governments to pick up the bill.

This report assesses the impact of four families of synthetic chemicals endemic in global food production. Phthalates and bisphenols are commonly used as plastic additives, employed in food packaging and disposable gloves used in food preparation.

Pesticides underpin industrial agriculture, with large-scale monoculture farms spraying thousands of gallons on crops to eliminate weeds and insects, and many crops treated after harvest to maintain freshness.

Pfas are used in food contact materials such as greaseproof paper, popcorn tubs and ice-cream cartons, but have also accumulated in the environment to such an extent they enter food via air, soil and water contamination.

All have been linked to harms including endocrine (hormone system) disruption, cancers, birth defects, intellectual impairment and obesity.

Landrigan said that during his long career in paediatric public health he had seen a shift in the conditions affecting children. "The amount of disease and death caused by infectious diseases like measles, like scarlet fever, like pertussis, has come way down," he said. "By contrast, there's been this incredible increase in rates of non-communicable diseases. And of course, there's no single factor there … but the evidence is very clear that increasing exposure to hundreds, maybe even thousands of manufactured chemicals is a very important cause of disease in kids."

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Landrigan said he was most concerned about "the chemicals that damage children's developing brains and thus make them less intelligent, less creative, just less able to give back to society across the whole of their lifetimes".

"And the second class of chemicals that I worry really worried about are the endocrine-disrupting chemicals," he added. "Bisphenol would be the classic example, that get into people's bodies at every age, damage the liver, change cholesterol metabolism, and result in increased serum cholesterol, increased obesity, increased diabetes, and those internally to increase rates of heart disease and stroke."

Asked whether the report could have looked beyond the groups of chemicals studied, Landridge said: "I would argue that they're only the tip of the iceberg. They're among the very small number of chemicals, maybe 20 or 30 chemicals where we really have solid toxicologic information.

"What scares the hell out of me is the thousands of chemicals to which we're all exposed every day about which we know nothing. And until one of them causes something obvious, like children to be born with missing limbs, we're going to go on mindlessly exposing ourselves."

The Guardian, 10 December 2025

https://theguardian.com

A new natural sunscreen: Novel compound discovered in thermophilic cyanobacteria

2025-12-18

Natural sunscreens shield the skin from harmful radiation, without triggering allergic reactions. In a recently published study, a group of researchers has discovered a novel compound, β-glucose-bound hydroxy mycosporine-sarcosine, which is produced in thermal cyanobacteria under UV-A/UV-B and salt stress. This compound has a unique biosynthesis pathway which is different from the typical mycosporine-like amino acids (MAAs) biosynthesis mechanism. This discovery aids industrial biotechnology in the production of natural UV-filter compounds.

Cyanobacteria adaptation and metabolite production

Cyanobacteria, the oxygen-producing photosynthetic bacteria, survive under extreme conditions. They produce a wide spectrum of primary and secondary metabolites to survive the extreme stressed environmental conditions.

Mycosporine-like amino acids (MAAs) are small, water-soluble molecules produced by cyanobacteria that function as ultraviolet (UV)-absorbing compounds. These compounds offer photoprotection and act as antioxidants by scavenging stress-induced reactive oxygen species (ROS). Even though they have a common basic structure, different MAA compounds discovered to date show large structural diversities, which also influence their bioactivity and function.

Discovery and analysis of a novel MAA

With a rising risk of harmful UV radiation exposure and skin cancer, researchers are focusing on bioactive compounds with photoprotective abilities. While chemical sunscreens offer the desired protection, they are also associated with allergic reactions and other harmful side effects. MAAs are biocompatible and considered safe for human use, making them immensely important for sustainable biotechnology and large-scale production of natural sunscreen.

In a new study, a team of researchers led by Professor Hakuto Kageyama from Meijo University and Professor Rungaroon Waditee-Sirisattha from Chulalongkorn University has discovered a novel MAA molecule from thermal cyanobacteria inhabiting hot springs in Thailand. The discovery also contributes to understanding the survival strategies of these cyanobacteria, surviving extreme environmental conditions.

"Understanding stress-responsive biosynthesis in extremophilic cyanobacteria may accelerate industrial biotechnology for natural pigment and antioxidant production," mentions Prof. Kageyama, while talking about the motivation behind the study. It was published in the Science of The Total Environment on December 20, 2025.

The team isolated eight thermophilic cyanobacterial strains from the Bo Khlueng hot spring in Ratchaburi Province, Thailand. Under experimental setup, the Gloeocapsa species BRSZ strain produced a novel UV-absorbing compound in response to UV-A and UV-B exposures.

This compound, identified as β-glucose-bound hydroxy mycosporine-sarcosine (GlcHMS326), was further analyzed for a detailed understanding of its structure and functional mechanism. This novel compound undergoes triple chemical modifications—glycosylation, hydroxylation, and methylation—which have not been reported in cyanobacteria-derived MAAs before. Genetic analysis showed that these cyanobacteria possess a unique branch of genes that are associated with these modifications.

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GlcHMS326 production is strongly induced by UV-A and UV-B irradiation and salt stress. Interestingly, even though the cyanobacteria are obtained from hot water springs, this particular MAA production is not associated with thermal stress.

Functional significance and potential applications

The chemical modifications in GlcHMS326 contribute to its unique structural and functional properties. Methylation can enhance the stability, UV absorption properties, and antioxidant capacity of MAA compounds. Glycosylation of MAAs has been proposed to enhance their stability and support photoprotection and antioxidative defense. This compound shows higher free-radical scavenging property compared to canonical MAAs, suggesting that the derivatized structure of GlcHMS326 contributes to its enhanced antioxidant potential.

The findings of this study contribute to understanding how cyanobacteria living in extreme environments have uniquely evolved metabolic pathways to produce a special natural UV-absorbing substance. This unique MAA plays a pivotal role in abiotic stress tolerance for Gloeocapsa species and likely serves multiple functions in this thermophilic cyanobacteria.

Highlighting the importance of the study, Prof. Waditee-Sirisattha mentions, "Cyanobacteria are deemed unique among the microbial world. Our recent study underscores that extremophilic cyanobacteria are not only ecologically important but also represent a key area of research for multiple disciplines."

The significance of this compound lies in its diverse functionality and the potential for sustainable, large-scale production using the cyanobacterial "biofactories." This compound can be utilized as an alternative to certain synthetic UV filters that raise environmental concerns, supporting the development of eco-friendly sunscreens. Its antioxidant activity also hints at its potential applications in anti-aging, skincare, and pharmaceutical formulations.

"This discovery reminds us that nature still holds many chemical surprises. Extremophilic cyanobacteria reveal uncommon molecules that can inspire new directions in basic science and sustainable biotechnology," concludes Prof. Kageyama.

Phys org, 18 December 2025

https://phys.org

Highly Efficient Material Turns Motion Into Power, Without Toxic Lead

2025-09-27

Scientists have developed a new material that converts motion into electricity (piezoelectricity) with greater efficiency and without using toxic lead - paving the way for a new generation of devices that we use in everyday life.

Publishing their discovery in Journal of the American Chemical Society, researchers from the University of Birmingham, University of Oxford, and University of Bristol describe a material that is both durable and sensitive to movement - opening possibilities for a wide range of innovative devices such as sensors, wearable electronics, and self-powered devices.

Based on bismuth iodide, an inorganic salt with low toxicity, the new soft, hybrid material rivals the performance of traditional lead-based ceramics but with lower toxicity and easier processing. It contains no lead compared to existing high-performance alternatives such as PZT (lead zirconate titanate), which is 60% lead, and can be produced at room temperature rather than 1000°C.

Dr Dominik Kubicki, from the University of Birmingham, said: "With performance comparable to commercial piezoelectrics but made from non-toxic bismuth, this discovery is a new pathway toward environmentally responsible technologies that can power sensors, medical implants, and flexible electronics of the future."

Piezoelectric materials generate electric charge when pressed or bent and can also deform when an electric field is applied. They are essential to technologies ranging from precision actuators – used in products like camera autofocus and inkjet printer pumps – to energy-harvesting sensors built into wearable technology like fitness trackers, smart clothing, and car airbag systems.

Understanding material behaviour

Researchers at the University of Birmingham used single-crystal X-ray diffraction and solid-state nuclear magnetic resonance (NMR) to understand the material's behaviour. They found that the way that organic and inorganic parts stick together through halogen bonding can be used to change when and how the material changes its structure, as well as improving piezoelectric performance. This understanding could also be

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useful for enhancing piezoelectric performance in other materials that combine organic and inorganic elements.

Dr Benjamin Gallant, from the University of Birmingham, who led the NMR study, said: "As an early career researcher, it's exciting to participate in research with the power to transform our society - almost every device we use in our daily lives contains piezoelectrics."

The research was jointly supervised by Professor Henry Snaith (Oxford), Dr Harry Sansom (Bristol), and Dr Dominik Kubicki (Birmingham), bringing together expertise in new materials, crystal design, and atomic-level structure characterisation.

The global piezoelectric materials market is worth over $35 billion and continues to grow rapidly - driven by demand in automotive, healthcare, robotics, and consumer electronics, where devices that convert motion into electricity or precise movement are essential.

Lead author Dr Esther Hung, from the University of Oxford's Department of Physics who led the research, said: "By fine-tuning the interactions between the organic and inorganic components, we were able to create a delicate structural instability that breaks symmetry in just the right way."

"This interplay between order and disorder is what gives the material its exceptional piezoelectric response. It's a different approach to piezoelectricity than in traditional materials such as lead zirconate titanate (PZT), and that's what's led to these big improvements."

Technology Networks, 27 November 2025

https://technologynetworks.com

This 1.5-Million-Year-Old Human Face Is Rewriting Human Evolution

2025-12-18

By digitally fitting together teeth and fossilized bone fragments, researchers reconstructed a strikingly well preserved face of a human ancestor that lived 1.5 million years ago. The find represents the first complete Early Pleistocene hominin cranium from the Horn of Africa and, discovered at Gona in Ethiopia, suggests that some of the earliest humans to leave Africa retained unexpectedly archaic facial features.

A fossil discovered at Gona in Ethiopia and dated to about 1.5 million years ago is offering new insight into the earliest human relatives to leave Africa.

An international research team led by Dr. Karen Baab, a paleoanthropologist at the College of Graduate Studies, Glendale Campus of Midwestern University in Arizona, created a digital reconstruction of the face of early Homo erectus. The fossil, known as DAN5 and dated to between 1.6 and 1.5 million years old, was recovered from the Afar region of Ethiopia. Its unexpectedly archaic facial structure is providing new perspectives on the species that later spread throughout Africa and into Eurasia. The research is being published in Nature Communications.

According to Dr. Baab, "We already knew that the DAN5 fossil had a small brain, but this new reconstruction shows that the face is also more primitive than classic African Homo erectus of the same antiquity. One explanation is that the Gona population retained the anatomy of the population that originally migrated out of Africa approximately 300,000 years earlier."

Gona, Ethiopia

The Gona Paleoanthropological Research Project, based in the Afar region of Ethiopia, is co directed by Dr. Sileshi Semaw (Centro Nacional de Investigación sobre la Evolución Humana, Spain) and Dr. Michael Rogers (Southern Connecticut State University). Research at Gona has uncovered hominin fossils dating back more than 6.3 million years, along with stone tools that document the past 2.6 million years of human technological evolution.

The updated reconstruction brings together a fossilized brain case (previously described in 2020) and several smaller pieces of the face from a single individual known as DAN5, which lived between 1.6 and 1.5 million years ago. Using digital methods, researchers reassembled the facial fragments (and teeth) to produce the most complete fossil human skull yet recovered from the Horn of Africa for this period.

The DAN5 specimen has been identified as Homo erectus, a species that persisted for a long time and spread widely across Africa, Asia, and Europe about 1.8 million years ago.

How did the scientists reconstruct the DAN5 fossil?

The researchers used high-resolution micro-CT scans of the four major fragments of the face, which were recovered during the 2000 fieldwork at Gona. 3D models of the fragments were generated from the CT scans. The face fragments were then re-pieced together on a computer screen, and the teeth were fit into the upper jaw where possible. The final step

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was "attaching" the face to the braincase to produce a mostly complete cranium. This reconstruction took about a year and went through several iterations before arriving at the final version.

Dr. Baab, who was responsible for the reconstruction, described this as "a very complicated 3D puzzle, and one where you do not know the exact outcome in advance. Fortunately, we do know how faces fit together in general, so we were not starting from scratch."

What did scientists conclude?

This new study shows that the Gona population 1.5 million years ago had a mix of typical Homo erectus characters concentrated in its braincase, but more ancestral features of the face and teeth normally only seen in earlier species. For example, the bridge of the nose is quite flat, and the molars are large. Scientists determined this by comparing the size and shape of the DAN5 face and teeth with other fossils of the same geological age, as well as older and younger ones.

A similar combination of traits was documented previously in Eurasia, but this is the first fossil to show this combination of traits inside Africa, challenging the idea that Homo erectus evolved outside of the continent. "I'll never forget the shock I felt when Dr. Baab first showed me the reconstructed face and jaw," says Dr. Yousuke Kaifu of the University of Tokyo, a co-author of the study.

"The oldest fossils belonging to Homo erectus are from Africa, and the new fossil reconstruction shows that transitional fossils also existed there, so it makes sense that this species emerged on the African continent," says Dr. Baab. "But the DAN5 fossil postdates the initial exit from Africa, so other interpretations are possible."

Dr. Rogers agrees. "This newly reconstructed cranium further emphasizes the anatomical diversity seen in early members of our genus, which is only likely to increase with future discoveries."

"It is remarkable that the DAN5 Homo erectus was making both simple Oldowan stone tools and early Acheulian handaxes, among the earliest evidence for the two stone tool traditions to be found directly associated with a hominin fossil," adds Dr. Semaw.

Future Research

The researchers are hoping to compare this fossil to the earliest human fossils from Europe, including fossils assigned to Homo erectus but also

a distinct species, Homo antecessor, both dated to approximately one million years ago. "Comparing DAN5 to these fossils will not only deepen our understanding of facial variability within Homo erectus but also shed light on how the species adapted and evolved," explains Dr. Sarah Freidline of the University of Central Florida, study co-author.

There is also potential to test alternative evolutionary scenarios, such as genetic admixture between two species, as seen in later human evolution among Neanderthals, modern humans, and "Denisovans." For example, maybe DAN5 represents the result of admixture between classic African Homo erectus and the earlier Homo habilis species. According to Dr. Rogers, "We're going to need several more fossils dated between one and two million years ago to sort this out."

Sci Tech Daily, 18 December 2024

https://scitechdaily.com

PFAS detection in 15 minutes: A sensor system for rapid on-site analysis

2025-12-18

PFAS are forever chemicals that do not degrade in the environment. They enter soil and water, accumulate in plants, animals and humans, and can be harmful to health. The problem: Until now, detecting them has been complicated, expensive, and only possible in a laboratory—too slow for a rapid response.

Researchers at the Federal Institute for Materials Research and Testing (BAM) have now developed a compact sensor system that detects PFAS directly on site in aqueous samples—quickly, reliably, and cost-effectively. The new method delivers results in less than 15 minutes and can detect even small amounts of these chemicals. The study has now been published in Nature Communications.

"PFAS are a global problem. With our technology, we are laying the foundation for rapid on-site analysis that will help authorities and companies monitor and remediate contaminated sites," says Knut Rurack, an expert in chemical and optical sensing at BAM.

The system works with a combination of tiny fluorescent particles and a microfluidic platform—in simple terms, a pocket-sized mini-laboratory. After preparing the water sample, the device shows a clear signal if PFAS are present.

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"Our goal was to create a robust, user-friendly, and scalable system. The combination of materials science and microfluidics opens up new avenues for monitoring cleaning and remediation processes in the context of environmental management—not only for PFAS, but also for other pollutants," explains Rurack.

The system is mobile, requires no complex laboratory equipment, and significantly reduces the analysis effort. In this way, BAM is making an important contribution to the protection of people and the environment and supporting the implementation of current legal requirements.

Phys Org, 18 December 2025

https://phys.org

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2025-09-27

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Technology Networks, 27 November 2025

https://technologynetworks.com

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Scientists discover unbelievable use for substance hidden in pomegranate trees

2025-12-03

Scientists in Germany are turning to pomegranate trees to help power the future of renewable energy. Researchers at Clausthal University of Technology recently developed a new method to recover lithium from smelting slags, the by-product left behind when ores are melted.

As reported by Interesting Engineering, the researchers used punicin — a naturally derived compound found in pomegranate leaves — to extract lithium from this by-product rock. In laboratory tests, the process achieved a 92% recovery rate, transforming industrial waste into a valuable resource and offering a cleaner, more sustainable way to meet the world's growing lithium needs.

In the technique, air bubbles lift lithium-bearing particles to the surface of a water-based slurry, separating them from unwanted material. Punicin then attaches to these lithium particles, rendering them hydrophobic and allowing them to float. The result is lithium recovered from waste rock, instead of being mined from the Earth.

Lithium plays a key role in technology and renewable power. The element powers the batteries that run our laptops and smartphones, making it vital to connectivity. But rechargeable lithium batteries also power electric vehicles and renewable energy storage systems, such as those powered by solar and wind. Given the constant growth of the tech and renewable energy sectors, the demand for lithium is skyrocketing.

Although lithium is essential to meeting the world's clean energy needs, its extraction comes at a steep cost. As Euronews reported, lithium mining often depletes water sources, contaminates soil and waterways, harms biodiversity, and contributes to planet-warming pollution — all while exploiting vulnerable workers and communities. Even so, lithium-ion batteries remain key to cleaner power — at least for now.

Efforts to recover lithium from waste materials can help mitigate the impacts of mining — but most current recovery methods are costly and inefficient, leaving large amounts of this valuable metal behind. That's where punicin extraction may be a game changer.

By using plant-derived compounds instead of harsh (and expensive) synthetic chemicals, this method minimizes environmental harm while reclaiming lithium from waste with high efficiency. Beyond lithium,

scientists hope this method could be used to recover other valuable metals like copper or tantalum, cleaning up the mining industry even further.

But, as Interesting Engineering pointed out, the method is still experimental within labs. Cost, energy efficiency, and purity of the recovered lithium still need to be assessed. The method's commercial viability will depend on how well the process performs when scaled.

However, the possibilities of punicin are exciting. Transforming slag into a more sustainable source of in-demand lithium could help reduce industrial waste, curb mining pressure, and lower the element's cost — all good things for the future of our power and our planet.

Here's hoping that pomegranate proves to be the fruit of clean energy's future.

The Cool Down, 3 December 2025

https://thecooldown.com

Light-controlled cholesterol 'look-alikes' point toward smarter drug delivery

2025-12-18

High levels of cholesterol are linked to heart disease, stroke, and many other health problems. However, this complex and vital fatty, water insoluble molecule—a lipid—is found in every cell of the body and is not all bad news. It also regulates crucial processes that science has yet to map.

"Cholesterol helps build membranes and serves as the starting point for important hormones like estrone and testosterone, so it shapes many aspects of our health and disease," says Michael Zott, a Beckman Postdoctoral Fellow at the University of Pennsylvania. Studying its behavior is tricky because it is tiny and hard to track, Zott says.

These constraints mean scientists often rely on "functional derivatives," or molecules designed to mimic cholesterol but which include chemical tags so they can be seen and tracked.

Innovative light-sensitive cholesterol mimics

In a paper published in the Journal of the American Chemical Society, Zott and a collaborative team led by his postdoctoral adviser Dirk Trauner have

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designed a new set of cholesterol proxies with light-sensitive compounds attached. Called "photocholesterols," these molecules change shape when exposed to light, allowing the researchers to toggle cholesterol's biological activity on or off.

This light-based system paves the way for advanced therapeutics, allowing drugs to be activated deep within the body where traditional controls fail. The team's ultimate goal is to enable wavelengths of light that can penetrate through the skin to reach organs targeted for medicine.

"The nice thing about using light to trigger these geometric changes in molecules we study is that certain forms of it can penetrate tissues quite deeply," says Trauner, co-senior author of the paper and a Penn Integrates Knowledge University Professor in the School of Arts & Sciences and the Perelman School of Medicine.

"This allows for what we usually call spatiotemporal control. A person could take the medicine systemically, and then we could activate it at a precise time in a precise place using a focused beam of light to turn the molecule on in only a certain location."

Unexpected findings and future directions

They found that the photocholesterols they created did not behave identically.

"While we initially aimed to make a molecule that would work in every possible application—a 'pan cholesterol' mimic—we came upon a powerful, fortuitous result," Zott says.

Instead of behaving identically, some photocholesterols strongly preferred certain transport proteins over others, and one candidate turned out to be possibly the first selective inhibitor of two poorly understood sterol transport proteins: ORP1 and ORP2.

"The work has already led to new discovery," says co-senior author of the paper Luca Laraia of the Technical University of Denmark. "We now have the first 'photoswitchable' inhibitors of ORP1 and ORP2—proteins we know play a critical role in cholesterol balance but whose function we haven't fully elucidated. This will significantly help us understand their biological roles."

"By finding molecules that are selective for them, that means we can begin to develop tools to turn them off or turn on, selectively," adds Zott, "and that will help us uncover what their function is down the line."

For future work, the team plans to leverage the precision of light to map when and where key sterol transport proteins move cholesterol within complex cellular models under normal and disease-like conditions.

They also plan to adapt the same computational design strategy to build light-controlled versions of other lipids, with the long-term goal of optimizing lipid nanoparticle formulations for applications like light-controlled mRNA delivery and designing systemic therapies that can be activated locally using focused beams of light, providing precise spatiotemporal control.

"Cholesterol is at the center of biology and underlies cutting-edge tools like the lipid nanoparticles used in modern vaccine technology," says Zott.

"By making a light-controlled version, we can begin to investigate, and potentially improve, all of these crucial processes."

Phys Org, 18 December 2025

https://phys.org

What Looked Like a Planet Was Actually a Cosmic Crash

2025-12-18

What looked like a mysterious exoplanet was actually the sparkling debris from a violent collision between massive space rocks. Even more astonishing, astronomers watched a second collision unfold in the same system, revealing a surprisingly chaotic neighborhood where new worlds may be born.

In a rare skywatching surprise, NASA's Hubble Space Telescope (HST) recorded the aftermath of space rocks smashing together in a nearby planetary system.

Astronomers first noticed a bright point of light and thought it was a dust-coated exoplanet shining by reflected starlight. Then the "exoplanet" faded away. Not long after, a different bright object appeared, and the international research team, including Northwestern University's Jason Wang, realized the objects were not planets. Instead, they were glowing debris left behind by a cosmic crash.

Researchers concluded that two separate, powerful impacts created two bright debris clouds inside the same planetary system. That makes the system a rare chance to watch processes linked to planet formation and to study the materials that can eventually gather into new worlds.

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The study will be published today (December 18) in the journal Science.

"Spotting a new light source in the dust belt around a star was surprising. We did not expect that at all," Wang said. "Our primary hypothesis is that we saw two collisions of planetesimals — small rocky objects, like asteroids — over the last two decades. Collisions of planetesimals are extremely rare events, and this marks the first time we have seen one outside our solar system. Studying planetesimal collisions is important for understanding how planets form. It also can tell us about the structure of asteroids, which is important information for planetary defense programs like the Double Asteroid Redirection Test (DART)."

"This is certainly the first time I've ever seen a point of light appear out of nowhere in an exoplanetary system," said lead author Paul Kalas, an astronomer at the University of California, Berkeley. "It's absent in all of our previous Hubble images, which means that we just witnessed a violent collision between two massive objects and a huge debris cloud unlike anything in our own solar system today."

Wang specializes in direct imaging of exoplanets. He is an assistant professor of physics and astronomy at Northwestern's Weinberg College of Arts and Sciences and a member of the Center for Interdisciplinary Exploration and Research in Astrophysics (CIERA).

Fomalhaut and the mystery of a disappearing "planet"

For years, scientists have debated the true identity of a bright object known as Fomalhaut b, long considered an exoplanet candidate orbiting just outside the star Fomalhaut. The star lies about 25 light-years from Earth in the Piscis Austrinus constellation. Fomalhaut is more massive than the sun and surrounded by a complex set of dusty debris belts.

"The system has one of the largest dust belts that we know of," said Wang, who is part of the team that has monitored the system for two decades. "That makes it an easy target to study."

Fomalhaut b was announced in 2008, but researchers have struggled to determine whether it was a real planet or a growing cloud of dust. In 2023, scientists used the HST to take a closer look, and the strange light source was gone. In its place, another bright point appeared, shifted slightly within the same system.

"With these observations, our original intention was to monitor Fomalhaut b, which we initially thought was a planet," Wang said. "We assumed the

bright light was Fomalhaut b because that's the known source in the system. But, upon carefully comparing our new images to past images, we realized it could not be the same source. That was both exciting and caused us to scratch our heads."

Two collisions and two expanding debris clouds

The disappearance of Fomalhaut b (now called Fomalhaut cs1) fits the idea that it was an expanding dust cloud that gradually dispersed, likely created by an impact. The arrival of the second bright object (now called Fomalhaut cs2) strengthens the case that neither source was a planet. Instead, both appear to be dusty leftovers from violent collisions between planetesimals — the rocky building blocks of planets.

The brightness and position of Fomalhaut cs2 closely resemble how Fomalhaut cs1 looked when it was first spotted about two decades earlier. By repeatedly imaging the system, the team estimated how often these planetesimal collisions may occur.

"Theory suggests that there should be one collision every 100,000 years, or longer. Here, in 20 years, we've seen two," Kalas said. "If you had a movie of the last 3,000 years, and it was sped up so that every year was a fraction of a second, imagine how many flashes you'd see over that time. Fomalhaut's planetary system would be sparkling with these collisions."

Because the claim is so unusual, Wang helped verify the result. He contributed one of four independent analyses confirming that the team detected two short-lived events in Fomalhaut's dust belt.

"This is the first time we're seeing something like this," Wang said. "So, we had to make sure we can trust our images and that we are measuring the properties of the collision properly. I crunched the numbers to show that the four independent analyses all confidently detect a new source around the vicinity of the star."

Why this matters for future planet hunts

The findings do more than reveal a rare natural laboratory for studying impacts. They also show how the dusty aftermath of a collision can be mistaken for a planet simply because it reflects starlight. That confusion could become a bigger issue as next-generation observatories, including the Giant Magellan Telescope, work toward directly imaging habitable-zone planets around nearby stars.

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DEC. 19, 2025

"Fomalhaut cs2 looks exactly like an extrasolar planet reflecting starlight," Kalas said. "What we learned from studying cs1 is that a large dust cloud can masquerade as a planet for many years. This is a cautionary note for future missions that aim to detect extrasolar planets in reflected light."

Even though Fomalhaut cs1 has now faded from view, the team will keep watching the Fomalhaut system. They plan to follow how Fomalhaut cs2 changes over time and to learn more about how collisions unfold in this neighboring stellar environment.

To do that, Wang, Kalas, and collaborators will use the Near-Infrared Camera (NIRCam) on NASA's James Webb Space Telescope (JWST). NIRCam can capture color information that HST's spectrograph instrument could not provide. Those color measurements can help reveal the dust grain sizes and what the debris cloud is made of, including whether it contains water and ice.

"Due to Hubble's age, it can no longer collect reliable data of the system," Wang said. "Fortunately, we now have the JWST. We have an approved JWST program to follow up this planetesimal collision to understand the new circumstellar source and the nature of its two parent planetesimals that collided."

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https://scitechdaily.com

CHEMWATCH

Bulletin Board

Technical Notes

DEC. 19, 2025

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CHEMICAL EFFECTS

sPLA2-IIA inhibitor Tricyclic Dipyrido Diazepinone derivative 6 f suppresses poultry organic dust-induced pulmonary inflammation by downregulating ERK1/2-cPLA2 pathway

Copper Nanoparticles Atomized into Zerovalent Copper Single Atoms at Water/Mineral Interfaces Mediated by ortho-Phenolic Hydroxyl of Dissolved Organic Matter

ENVIRONMENTAL RESEARCH

The association of environmental toxicants exposure with cardiovascular disease risk: A comprehensive analysis from population to molecular mechanism

Seasonal dynamics of groundwater pollution and health risks in municipal solid waste-affected urban settlements of Bengaluru, Kolkata and Durgapur, India

Identification and assessment of urban groundwater pollution based on Monte Carlo health risk modeling and self-organizing map (SOM)

PHARMACEUTICAL/TOXICOLOGY

Silver Nanoparticles Synthesized From Aloe vera Extract Have Lower Toxicity Than Chemically Synthesized Forms on Hepatic, Renal, Oxidative/Antioxidative Profiles, and Histopathological Damage in Male Mice

Preliminary insights into methylation patterns in Agent Orange exposed thyroid cancers: a pilot study

OCCUPATIONAL

Association of co-exposure to EDCs in early pregnancy with threatened abortion: The mediation effect of progesterone

Water consumption contributes to maternal PFAS exposure: From source to metabolic perturbations

Arsenic exposure, arsenic metabolism, and plasma lipidome in relation to type 2 diabetes and glycemic traits: a lipidome-wide association study