CHEMWATCH

Bulletin Board

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ASIA PACIFIC

India adopts circular economy to drive growth and environmental sustainability

2025-01-27

India is progressively embracing circular economy principles, establishing itself as a global leader in sustainability. Implementing these practices could result in savings of up to 11% of GDP by 2030 and 30% by 2050. This transition aligns with India's vision of "Viksit Bharat" and its commitment to achieving net-zero emissions by 2070.

While globalization has connected economies and cultures, it has also brought significant environmental challenges. Increased consumption, production, and industrialization have led to resource depletion, rising greenhouse gas emissions, and climate risks. In contrast, circular economy principles promote sustainability by transitioning from the linear model of "take, make, dispose" to a regenerative approach that emphasizes restoring and reusing resources.

Each year, over 100 billion tons of resources are introduced into the global economy, but only 8.6% are recycled. According to the 2021 Circularity Gap Report, the global economy is just 8.6% circular, with an ambition to reach 17% by 2030 by targeting high-potential sectors. Achieving this goal requires promoting product designs that prioritize durability, reparability, and recyclability, paving the way for a sustainable future.

The circular economy enhances supply chain resilience by reducing dependence on scarce resources, helping businesses mitigate global supply chain volatility. By prioritizing material recovery and reuse, it minimizes reliance on new raw materials, stabilizes prices, and ensures resources are utilized for extended periods. This model decouples economic growth from resource consumption, making it essential for achieving long-term sustainability.

India's government is driving the transition to a circular economy through targeted policies such as the Plastic Waste Management Rules, e-Waste Management Rules, Construction and Demolition Waste Management Rules, and the Metals Recycling Policy.

Read More

The Guardian, 27-01-25

https://www.ippmedia.com/the-guardian/news/world/read/india-adopts-circular-economy-to-drive-growth-and-environmental-sustainability-2025-01-27-123359

NSW councils fear PFAS contamination will risk water security in drought

2025-02-05

Regional New South Wales councils grappling with PFAS contamination in drinking water supplies have warned their communities could face "catastrophic" situations during future droughts without immediate state government help.

Numerous members of the NSW Country Mayors Association fronted the upper house inquiry into PFAS contamination in the state's drinking water supplies and waterways.

Today's hearing at NSW Parliament House in Sydney follows two other sittings in Katoomba and Newcastle this week, which saw members from impacted communities give evidence.

Read More

ABC News, 05-02-25

https://www.abc.net.au/news/2025-02-05/pfas-drought-water-supply-security-nsw/104899708

Improving hazardous substances application timeframes

2025-02-05

Over the coming months, the EPA will begin making a raft of improvements that will reduce the time it takes to process hazardous substances applications.

We'll be:

- bolstering our frontline by recruiting a new team to assess applications
- developing new group standards for low-risk hazardous substances

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- working with the Ministry for the Environment on amendments to the HSNO Act
- improving communication and transparency with applicants.

While some of these changes will take time, we're excited to progress this work and expect these changes will start to have an impact on our capacity to process applications within a year to 18 months.

Read More

EPA NZ, 05-02-25

https://www.epa.govt.nz/news-and-alerts/newsletters/hazardous-substances-update/

Feedback sought on treated seed proposal

2025-02-05

The EPA is inviting feedback on a proposed group standard for treated seed that will reduce inconsistencies, and help protect the environment and people from the adverse effects of hazardous substances. The group standard would apply to both imported treated seed and seed that is treated in New Zealand.

Treated seed has been coated with a hazardous substance, such as a pesticide, to prevent damage from pest species before or after planting. The main aim of the revised regulations is to put in place consistent and streamlined rules around importing, manufacturing, supplying, storing, using, or disposing of treated seed.

To make sure we have the right information to ensure a practical and effective approach to regulating treated seeds, we are seeking views on this proposal before we implement any changes. To assist people wanting to make a submission, we're holding a webinar on 18 February 2025 for those wanting to learn more about the proposed changes.

Register for the webinar

Submissions on the proposal close at 5pm on Monday, 31 March 2025.

Read More

EPA NZ, 05-02-25

https://www.epa.govt.nz/news-and-alerts/newsletters/hazardous-substances-update/

Annual reports for import / export of ozone-depleting substances due

2025-02-05

If you import or export any controlled substances under the Ozone Layer Protection Act 1996, you must submit a report on these each calendar year. The deadline to submit this information to the EPA was 31 January. This information is required for New Zealand's reporting to the United Nations.

Examples of controlled substances include ozone depleting substances, such as chlorofluorocarbons (CFCs), methyl bromide, and hydrofluorocarbons (HFCs).

Read More

EPA NZ, 05-02-25

https://www.epa.govt.nz/news-and-alerts/newsletters/hazardous-substances-update/

AMERICA

EPA releases draft evaluation of PFAS in biosolids

2025-01-18

On Jan. 14, the U.S. Environmental Protection Agency (EPA) released a draft risk assessment of the potential human health risks associated with the presence of toxic per- and polyfluoroalkyl substances (PFAS) chemicals in biosolids, also known as sewage sludge.

The findings for the draft risk assessment — essentially a scientific evaluation — show that there may be human health risks associated with exposure to the "forever chemicals" PFOA or PFOS with all three methods of using or disposing of sewage sludge – land application of biosolids, surface disposal in landfills, or incineration. EPA said once finalized, the assessment will help the agency and its partners understand the public health impact of forever chemicals in biosolids and inform any potential future regulation.

"This draft assessment provides important information to help inform future actions by federal and state agencies as well as steps that wastewater systems, farmers and other stakeholders can take to protect people from PFAS exposure, while ensuring American industry keeps

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feeding and fueling our nation," said said EPA Acting Administrator Jane Nishida.

Defining Biosolids

Wastewater produced by households and businesses, and sometimes industrial dischargers, is conveyed to a wastewater treatment plant, and ultimately treated. These treatment processes also produce a semi-solid, nutrient-rich product known as "sewage sludge" or "biosolids." EPA typically uses the term "biosolids" to mean sewage sludge that has been treated to meet regulatory standards and is thereby suitable to be land applied as a soil conditioner or fertilizer. In turn, biosolids can be beneficially reused as land applied fertilizer on agricultural fields or on nonagricultural lands to promote plant health and productivity.

Read More

Water Finance & Management, 18-01-25

https://waterfm.com/epa-releases-draft-evaluation-of-pfas-in-biosolids/

Industry eyes fee reauthorization to update US chemicals law

2025-01-29

Proposal comes as Republicans introduce bill to roll back trichloroethylene restrictions

Just days after President Donald J. Trump was sworn into office for his second term, Republicans in the House of Representatives introduced legislation to roll back a recent EPA regulation that restricts the widely used solvent trichloroethylene (TCE). Legislators also heard from industry representatives about the need to accelerate the approval of new chemicals and a proposed mechanism for updating the country's primary chemicals law.

During a Jan. 22 subcommittee hearing of the House Energy and Commerce Committee, executives from the American Chemistry Council (ACC) and the American Fuel & Petrochemical Manufacturers, along with a chemical industry consultant, testified that the US Environmental Protection Agency is taking too much of a precautionary approach to managing the health risks of chemicals.

"Due to unrealistic assumptions about exposures to chemicals, the EPA's approach has led to unnecessary overregulation that is out of step with

the rest of the world," Chris Jahn, president and CEO of the ACC, told lawmakers. He pointed to the EPA's recent evaluation of formaldehyde as an example, noting that the exposure limit is 3 times lower than that in the European Union.

Rep. Diana Harshbarger (R-Tenn.) agreed with Jahn that the EPA is overregulating chemicals and setting limits that are impossible to meet. She said that a manufacturer of lithium-ion battery separators in her district is "currently facing an existential threat due to a final rule of the Biden administration made related to trichloroethylene."

On the same day as the hearing, Harshbarger and Mariannette Miller-Meeks (R-IA) introduced a resolution (H.J. Res. 27) that proposes to use the Congressional Review Act to overturn the EPA's final rule on TCE, which was issued last month. Congress can use the act to review and disapprove federal agency rules for up to 60 days after a rule is issued.

Read More

C&en, 29-01-25

https://cen.acs.org/policy/chemical-regulation/Industry-eyes-fee-reauthorization-update/103/web/2025/01

5 Regulatory and Legislative Predictions for Safety Heading Into 2025

2025-01-17

Now that we have entered 2025, the landscape of workplace safety, regulatory compliance and environmental standards is poised for significant transformation.

With Donald Trump returning to the presidency and a Republican-controlled Senate and House, the regulatory agenda is expected to shift dramatically, impacting the safety field, according to Adele Abrams, Esq., CSP, CMSP, president of the safety-focused Law Office of Adele L. Abrams P.C.

Drawing from ongoing legislation, recent court cases and publicly available Project 2025 information, Abrams examined key areas that may be affected in a recent webinar sponsored by ASSP's Women in Safety Excellence Common Interest Group. These areas include challenges to OSHA's authority and proposed regulations, environmental laws, the demise of Chevron deference, and the evolving role of courts in safety adjudication.

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1. OSHA's Authority May Be Challenged

A major question for many safety professionals involves challenges to the Occupational Safety and Health Act, the landmark legislation that established OSHA and shaped workplace safety as we know it today.

In early 2023, Rep. Andy Biggs (R-AZ) proposed H.R.69, the NOSHA Act, which sought to eliminate OSHA. The proposal did not gain traction because a Democrat-controlled Senate would likely quash the bill, even if it passed the House, Abrams says.

But with a more conservative Congress sworn in this January, Abrams believes this legislation will likely be reintroduced and advance through hearings.

The courts present another potential route to eliminating OSHA. The Allstates Refractory Contractors LLC v. Su case challenged OSHA's constitutionality under the nondelegation doctrine. While similar challenges failed in the past and the U.S. Supreme Court declined to hear this case in 2024, dissenting opinions from Justices Clarence Thomas and Neil Gorsuch signal that the issue might be reconsidered.

Read More

American Society of Safety Professionals, 17-01-25

https://www.assp.org/news-and-articles/5-regulatory-and-legislative-predictions-for-safety-heading-into-2025

EUROPE

~ Nordic Sustainable Construction: Results resonate in the EU

2025-02-05

The hidden cost of Europe's battle against PFAS contamination

In short:

- PFAS chemicals, used since the 1940s for their non-stick and water-resistant properties, have contaminated at least 23,000 sites across Europe, posing risks like cancer, infertility and immune system damage.
- Cleaning up PFAS could cost between €95 billion and €2 trillion over 20 years, not including healthcare costs, with "emerging" PFAS like trifluoroacetic acid requiring even more expensive decontamination efforts.

- Without strict regulations to stop new emissions, decontamination efforts are futile, as PFAS continue to accumulate in water, soil and living organisms.

Key quote:

"There is not enough money in the world to remove PFAS from the environment as fast as we are adding it right now."

— Ali Ling, environmental engineer

Why this matters:

PFAS exposure is linked to serious health problems, including cancer and immune dysfunction. There are serious questions about whether Europe has the financial will and technological tools to accomplish the colossal task of removing PFAS from contaminated sites. Without strict and effective regulations to stop PFAS at the source, Europe's efforts to reclaim its poisoned soil and water will be as futile as bailing out a sinking ship with a teaspoon.

Read More

EHN, 05-02-25

https://www.ehn.org/the-hidden-cost-of-europes-battle-against-pfas-contamination-2671089389.html

The Furniture and Furnishings (Fire) (Safety) Regulations Amendment 2025

2025-01-22

OPSS has announced that while working to finalise longer-term reforms, the Government will lay a statutory instrument (SI) to amend the 1988 Furniture and Furnishings (Fire) (Safety) Regulations. Changes to the existing legislation will be made as soon as parliamentary time allows and will take effect six months later.

These changes reflect areas of broad stakeholder consensus, where the government feel it is better to act now rather than wait for the full reforms to be completed and implemented.

The immediate action taken to amend the 1988 Regulations will be:

- Removing certain baby products from scope to address concerns about exposure to chemical flame retardants of young children without compromising fire safety

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- Removing the requirement to attach display labelling to reduce burdens on businesses

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FIRA, 22-01-25

https://www.fira.co.uk/news/article/opss-announce-the-furniture-and-furnishings-fire-safety-amendment-regulations-2025

EU Soil Strategy Actions Tracker

2025-01-30

The EU Soil Strategy for 2030 sets out a framework to ensure that soils are used sustainably by setting concrete measures to protect and restore soils. It sets a vision and objectives to achieve healthy soil by 2050, with concrete actions due by 2030. The newly developed 'EU Soil Strategy Actions Tracker' is a tool to track the progress of these concrete actions since the adoption of the EU Soil Strategy in 2021. The EU Soil Strategy Actions Tracker provides an overview on the status of the actions, information on the due date, recent updates, links to related EU policies, links to relevant sources, and the main actors responsible for implementation. Currently, 62 out of 90 actions (69%) are marked as completed, 24 actions (27%) as in progress, and 4 actions (4%) as withdrawn. The EU Soil Strategy Actions Tracker provides a clear overview of the progress made by the European Commission under the EU Soil Strategy. With almost 70% of complete actions, the tracker shows that the Commission is well on track to complete most of the actions included in the EU Soil Strategy. Together with the EU Soil Observatory (EUSO) Soil Degradation Dashboard, it provides an informative overview on EU soil health status and ongoing actions to preserve and restore the state of soils in the EU. The EU Soil Strategy Actions Tracker is the first step towards an EUSO Soil Policy Actions Tracker to monitor EU policy actions relevant to soils, other policies (e.g. EU Climate Law) are foreseen to be included in 2025.

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EU Commission, 30-01-25

https://publications.jrc.ec.europa.eu/repository/handle/JRC140333

INTERNATIONAL

Alternatives to PFAS are available for many applications

2025-02-04

With their article published January 24, 2025, in the journal Environmental Science & Technology, Romain Figuière and co-authors from Stockholm University, Sweden, take an important step towards the phase-out of per- and polyfluoroalkyl substances (PFAS) by mapping their applications and currently available alternatives.

PFAS, also known as "forever chemicals," are a group of over 10,000 man-made chemicals that are highly persistent (FPF reported), widely spread in the environment (FPF reported), detected in humans and associated with several health outcomes (FPF reported and here). In 2023, Denmark, Germany, The Netherlands, Sweden, and Norway submitted a restriction proposal under the European Commission's Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH) Regulation to prohibit the manufacture, placing on the market, and use of all PFAS (FPF reported). Further, several states in the US have proposed to restrict PFAS use (FPF reported). A strategic approach allows for transitioning away from PFAS while avoiding "regrettable substitutions" (FPF reported).

Following such a strategic, systematic approach, Figuière and co-authors identified 325 applications of PFAS. As of April 2024, 40 suitable alternatives are available. Furthermore, the compiled information can be used to identify uses of PFAS that are not essential (FPF reported), for instance, where safer suitable alternatives are available. The latter is the case for 10% of PFAS uses. As of the time of compiling the overview (April 2024), no alternatives were identified for 83 applications which "should be the focus of further research activities."

Read More

FPF, 04-02-25

https://foodpackagingforum.org/news/alternatives-to-pfas-are-available-for-many-applications

One Health: EU agencies unite to tackle azole fungicide resistance in Aspergillus fungi

2025-02-06

The extensive use of azole fungicides, particularly in some agricultural and horticultural practices, can increase the risk of Aspergillus fungi developing resistance to essential antifungal treatments. This finding is highlighted in a report by the five EU health and environment agencies, with support from the European Commission's Joint Research Centre (JRC). The Agencies collaborated under a One Health approach to address this growing threat.

Helsinki, 30 January 2025 – For the first time, the five EU health and environment agencies – ECHA, European Food Safety Authority (EFSA), European Centre for Disease Prevention and Control (ECDC), European Environment Agency (EEA) and European Medicines Agency (EMA) – supported by the JRC, reviewed how the use of azole substances outside human medicine affects public health.

Azole medicines are essential for treating aspergillosis, a serious infection caused by Aspergillus fungi. However, these fungi are increasingly becoming resistant to azole therapies, making treatment less effective.

Azole substances are widely used in plant protection products ('pesticides') to control fungal diseases in agriculture and horticulture, as veterinary medicines to treat fungal infections in animals, as biocides in wood preservatives, as industrial chemicals (e.g. intermediates and dyes), and in cosmetics (e.g. as anti-dandruff agents).

The joint report highlights that their broad use outside human medicine, particularly in agriculture, contributes to the risk of Aspergillus becoming azole-resistant. Exposure to certain environments where azole fungicides are used or present, such as agricultural and horticultural waste and freshly cut wood, can potentially increase the risk of infection with azole-resistant Aspergillus spp.

Data collected from EU/EEA countries (2010–2021) and included in the report detail the use of azole fungicides across Europe. Plant protection products account for most of the reported sales across all sectors.

Dr Sharon McGuinness, ECHA's Executive Director said:

"ECHA proudly supports the European Union's efforts to safeguard public health and the environment from the growing threat of antifungal resistance. Addressing azole resistance, arising from both human and

environmental exposure to these chemicals, highlights the importance of a coordinated One Health approach. By combining expertise from EU agencies in agriculture, biocides, environment, medicine and veterinary care, we can help combat the development of resistance more effectively."

Main recommendations

Tackling azole resistance in Aspergillus requires cross-sectoral collaboration. The One Health approach brought together EU experts from human and veterinary medicine, agriculture and environmental sciences to review existing evidence, identify factors that promote azole resistance, and propose measures to prevent and control it.

Recognising the interconnected nature of this challenge, the Agencies' experts recommended the following actions:

- Adding new specific requirements to the approval and authorisation processes for azole fungicides;
- Supporting research into and development of new fungicides with innovative mechanisms of action that do not lead to resistance to antifungal medicines used in human treatments;
- Following good agricultural and horticultural practices, properly storing organic waste, managing waste effectively, and using and disposing azole-treated products responsibly;
- Implementing effective waste management for wood treated with azole-based biocides;
- Collecting more data on the uses of azole-based fungicides and of azole-based antifungals;
- Further developing specific technical guidance and risk assessment methodologies to support regulatory decisions on the approval of azole substances and to mitigate the risk of azole resistance in Aspergillus; and
- Conducting further research to address existing uncertainties.

The report reinforces the value of a One Health approach in addressing complex health threats like antifungal resistance. By continuing cross-disciplinary collaboration, we can strengthen surveillance, advance research, and implement effective measures to safeguard public health, animal health, and the environment.

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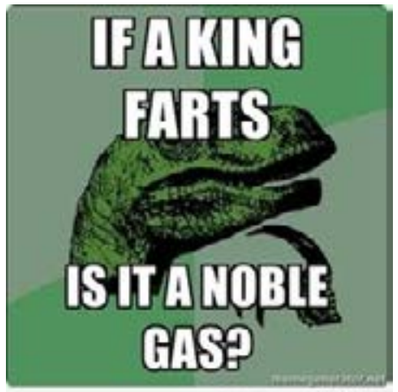
Read More

ECHA, 06-02-25

https://echa.europa.eu/-/one-health-eu-agencies-unite-to-tackle-azole-fungicide-resistance-in-aspergillus-fungi

Noble Gas

2025-02-14



9gag.com

Arsenic

2025-02-14

Arsenic is a chemical element with the symbol As, atomic number 33 and relative atomic mass 74.92. [1] It is a naturally occurring element that is widely distributed in the Earth's crust. Arsenic is classified chemically as a metalloid, having both properties of a metal and a nonmetal; however, it is frequently referred to as a metal. Elemental arsenic (sometimes referred to as metallic arsenic) is a steel grey solid material. However, arsenic is usually found in the environment combined with other elements such as oxygen, chlorine, and sulfur. Arsenic combined with these elements is called inorganic arsenic. Arsenic combined with carbon and hydrogen is referred to as organic arsenic. Most inorganic and organic arsenic compounds are white or colourless powders that do not evaporate. They have no smell, and most have no special taste. Thus, you usually cannot tell if arsenic is present in your food, water, or air. Inorganic arsenic occurs naturally in soil and in many kinds of rock, especially in minerals and ores that contain copper or lead.

USES [2,3]

Arsenic has a wide variety of uses in several industries. It is used:

- in the manufacture of arsenic compounds,
- in preparing hardened lead shot (i.e. an alloy of lead and arsenic),
- in alloys used for making boiler tubes,
- in insecticides and weed-killers,
- in the electronics industry in the manufacture of semiconductors, and
- arsenic in the form of gallium arsenide is used in semiconductor lasers.
- wood preservation [4]

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- **Industry sources:** Mining and metal manufacturing are the largest sources of arsenic in Australia. Electricity supply, water supply, sewerage and draining surfaces, can also emit arsenic. Manufacturing industries where arsenic may be used include: food, paper and paper products, glass and glass products, petroleum and coal products and chemicals.

- **Diffuse sources:** Paved and unpaved roads, windblown dust, burning fuels or wildfires, motor vehicles, solid, liquid and gas fuel combustion, lawn mowing, boating (recreational and commercial), railways, barbeques and backyard incineration activities are all capable of causing arsenic emissions.
- **Natural sources:** Arsenic and compounds occurs naturally in the earth's crust in ores and minerals. These are generally at low concentrations. Arsenic is released into the air by volcanoes and the weathering of arsenic-containing ores.
- **Transport sources:** Arsenic emissions may be present from the vehicle exhaust of cars, aeroplanes, railway operations and from commercial shipping or boating.
- **Consumer products:** Consumer products containing arsenic include timber treatments, wood preservatives, and pesticides.

Routes of Exposure

- **Inhalation** – Minor route of exposure for the general population. Predominant route for occupational exposure.
- **Oral** – Predominant route of exposure for the general population; for most individuals, diet is the largest source of arsenic exposure. Ingestion of arsenic in dirt through hand-to-mouth activity may be an important route of exposure for young children.
- **Dermal** – Minor route of exposure

HEALTH EFFECTS [4]

Acute Health Effects

- Acute inhalation exposure of workers to high levels of arsenic dusts or fumes has resulted in gastrointestinal effects (nausea, diarrhoea, abdominal pain), while acute exposure of workers to inorganic arsenic has also resulted in central and peripheral nervous system disorders.
- Acute oral exposure to inorganic arsenic, at doses of approximately 600 micrograms per kilogram body weight per day (µg/kg/d) or higher in humans, has resulted in death. Oral exposure to lower levels of inorganic arsenic has resulted in effects on the gastrointestinal tract (nausea, vomiting), central nervous system (CNS) (headaches, weakness, delirium), cardiovascular system (hypotension, shock), liver, kidney, and blood (anaemia, leukopenia).
- Acute animal tests in rats and mice have shown inorganic arsenic to have moderate to high acute toxicity.

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Carcinogenicity

- Human, inhalation studies have reported inorganic arsenic exposure to be strongly associated with lung cancer.
- Ingestion of inorganic arsenic in humans has been associated with an increased risk of nonmelanoma skin cancer and also to an increased risk of bladder, liver, and lung cancer.
- EPA has classified inorganic arsenic as a Group A, human carcinogen.

Other Effects

- Several studies have suggested that women who work in, or live near, metal smelters may have higher than normal spontaneous abortion rates, and their children may exhibit lower than normal birthweights. However, these studies are limited because they were designed to evaluate the effects of smelter pollutants in general, and are not specific for inorganic arsenic.
- Ingested inorganic arsenic can cross the placenta in humans, exposing the foetus to the chemical.

SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.
- **Skin Contact:** After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cover the irritated skin with an emollient. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.
- **Serious Skin Contact:** Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- **Inhalation:** Allow the victim to rest in a well-ventilated area. Seek immediate medical attention.
- **Ingestion:** Do not induce vomiting. Examine the lips and mouth to ascertain whether the tissues are damaged, a possible indication that the toxic material was ingested; the absence of such signs, however,

is not conclusive. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Workplace Controls & Practices [4]

Control measures include:

- Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits.
- If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protective Equipment [5]

The following safety equipment is recommended when handling arsenic:

- Safety glasses;
- lab coat;
- dust respirator (be sure to use an approved/certified respirator or equivalent;
- gloves.

Personal Protection in Case of a Large Spill:

- Splash goggles;
- full suit;
- dust respirator;
- boots;
- gloves.
- A self-contained breathing apparatus should be used to avoid inhalation of the product.
- Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

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REGULATION

United States

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
OSHA Permissible Exposure Limit (PEL)-General Industry See 1910.1018 Inorganic Arsenic	0.01 mg/m³ TWA 5 µg/m³ Action Level	HE1	Cancer (lung, lymphatic)
		HE3	Liver effects (cirrhosis, hepatitis)
		HE4	Acute toxicity, including respiratory and gastrointestinal effects
		HE7	Nervous system effects (peripheral neuritis)
		HE15	Skin, eye, mucous membrane, and respiratory irritation; skin sensitization; contact dermatitis; keratosis
OSHA PEL - Construction Industry See 1926.1118 Inorganic Arsenic	mg/m³ TWA 5 µg/m³ Action Level	HE1	Cancer (lung, lymphatic)
		HE3	Liver effects (cirrhosis, hepatitis)
		HE4	Acute toxicity, including respiratory and gastrointestinal effects
		HE7	Nervous system effects (peripheral neuritis)
		HE15	Skin, eye, mucous membrane, and respiratory irritation; skin sensitization; contact dermatitis; keratosis

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
OSHA PEL - Shipyard Employment See 1915.1018 Inorganic Arsenic	0.01 mg/m³ TWA 5 µg/m³ Action Level	HE1	Cancer (lung, lymphatic)
		HE3	Liver effects (cirrhosis, hepatitis)
		HE4	Acute toxicity, including respiratory and gastrointestinal effects
		HE7	Nervous system effects (peripheral neuritis)
		HE15	Skin, eye, mucous membrane, and respiratory irritation; skin sensitization; contact dermatitis; keratosis
National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL)	0.002 mg/m³ Ceiling (15 minute) Ca	HE1	Cancer (skin, lung, lymphatic)
		HE3	Reduced peripheral circulation, increased mortality due to cardiovascular failure, cirrhosis of the liver
		HE7	Peripheral neuritis and neuropathy, weakness of the arms and legs
		HE12	Anaemia
		HE14	Eye and skin irritation; contact dermatitis; sensitization; ulceration and perforation of the nasal septum

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Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) (2001)	0.01 mg/m³ (as As) A1; BEI	HE1	Cancer (skin and lung)
		HE3	Liver and peripheral vascular effects
		HE14	Skin irritation and upper respiratory effects, including a perforated nasal septum
CAL/OSHA PELs	0.01 mg/m³ TWA 0.005 mg/m³ Action Level	HE1	Cancer (skin and lung)
		HE3	Liver and peripheral vascular effects
		HE14	Skin irritation and upper respiratory effects, including a perforated nasal septum

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4. http://www.npi.gov.au/resource/arsenic-and-compounds-0
5. http://www.atsdr.cdc.gov/toxguides/toxguide-2.pdf
6. http://www.epa.gov/ttn/atw/hlthef/arsenic.html
7. http://www.sciencelab.com/msds.php?msdsId=9922970

Hyrdogel soaks up cosmic rays to protect space travelers

2025-02-11

Hydrogel is something that most of us are familiar with from it being used in contact lenses, burn dressings, and hair gel. In future, it might also be used to shield astronauts from the hazard of deadly cosmic radiation on long space voyages.

One of the major hazards of space travel is prolonged exposure to radiation. Outside of the Earth's atmosphere, an astronaut aboard the International Space Station (ISS) is exposed to about 72 millisieverts (mSv) of cosmic radiation during a six-month tour of duty, or the equivalent to several years of exposure that they'd absorb on Earth.

It's even worse on one of the planned missions to Mars when the interplanetary spacecraft ventures beyond Earth's protective magnetic field. If such a voyage took three years, the crew would take in over 1,000 mSv, which is almost 200 times Earth exposure.

Speed can help to minimize this exposure but the main protection is some kind of shielding that can absorb the radiation before it can do any harm. With its density and abundance of hydrogen atoms, water is particularly effective. Line a spacecraft with tanks of it and that would simplify matters nicely.

The problem is that water is a liquid. That's bad enough when there's gravity but in the weightless conditions of space, water can slosh around as it likes, leaving gaps in the shielding. Worse, water can leak, which can cause all sorts of mischief, from shorting out electrical circuitry to posing the novel threat to astronauts of drowning in deep space.

Based on new research by scientists at the Polymer Chemistry and Biomaterials Group (PBM) at Ghent University in Belgium, one solution is to trap the water inside an advanced super-absorbent polymer (SAP) that soaks up water like nobody's business. Expose it to water and the SAP increases in weight several hundred times as it forms a hydrogel. Form it using 3D printing and you have your radiation shielding.

According to ESA, such a hydrogel would not only act as a shield for spaceships that wouldn't slosh or leak, it could also be used to line spacesuits. This is particularly important because a shielded spacecraft isn't much good once an astronaut leaves it. Shielded suits would allow crews to spend more time on spacewalks or planetary EVAs. Even if the suit was punctured, the hydrogel would remain in place, allowing the wearer

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time to reach safety. It might even, conceivably, be configured to act as a sealant – much like that used in military aircraft fuel tanks.

"There is a constant search for lightweight radiation protection materials," said Peter Dubruel. "In our Discovery activity we successfully demonstrated that hydrogels are safe to use under space conditions. In this follow-up project, we are applying different techniques to shape the material into a 3D structure and scale up the production process, so that we can come a step closer to industrialization."

Source: ESA

New Atlas, 11 February 2025

https://newatlas.com

Oxytocin Neurons Key to Social Deficits in Autism

2025-02-07

Specific neurons that secrete the neuropeptide oxytocin in the brain are disproportionately disrupted in a mouse model of autism, RIKEN neuroscientists have found1. Artificially stimulating neurons restored social behaviors in these mice. These findings could help to develop new ways to treat autism.

Neurodevelopmental disorders such as autism spectrum disorder have been widely studied, but the molecular mechanisms that underlie them remain largely unknown.

In neurodegenerative diseases such as Parkinson's disease, certain types of neurons are more likely to accumulate disease-related proteins and have their functions impaired. This phenomenon is known as selective neuronal vulnerability.

Knowing which neurons most vulnerable helps are explain the symptoms of neurodegenerative diseases. It can also guide the development of targeted therapeutic approaches.

But is not known whether selective neuronal vulnerability also applies to neurodevelopmental disorders such as autism spectrum disorder.

Now, Kazunari Miyamichi of the RIKEN Center for Biosystems Dynamics Research and his colleagues have found that oxytocin-secreting neurons—known for their key role in establishing and maintaining social bonds—are selectively disrupted in a neurodevelopmental disorder model associated with atypical social traits.

They used the valproic-acid mouse model of autism spectrum disorder; such mice exhibit reduced social behaviors as a result of being exposed to the anti-epileptic drug valproic acid in the womb.

Miyamichi and his team found that they also have lower oxytocin levels in the brain region housing parvocellular oxytocin neurons that mediate social reward processes.

Single-cell RNA sequencing revealed that many genes crucial for neural function were expressed differently in these cells compared to control mice and that oxytocin gene expression is significantly reduced.

This came as a surprise to the team. "Given the systemic effects of valproic acid, impacting the entire body of embryos without spatial or cell type specificity, we didn't expect that certain cell types would be disproportionately affected," says Miyamichi.

Even more surprising was the finding that stimulating these cells shortly after birth led to a gradual but significant increase in oxytocin expression. It also enhanced social behaviors, with mice displaying more exploratory interactions with other mice. Remarkably, a single activation during the neonatal stage had a lasting effect, restoring gene expression and improving social behaviors into young adulthood.

Together, the findings suggest that the concept of selective neuronal vulnerability is applicable to neurodevelopmental disorders and that stimulating the affected cells could restore their function.

These discoveries could have implications for people, Miyamichi says. "Unraveling this recovery process may offer valuable insights into potential strategies for addressing social deficits in a range of human neurodevelopmental disorders."

Further clinical investigations are needed to explore this exciting possibility.

Technology Networks, 7 February 2025

https://technologynetworks.com

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PFAS in fertilisers blamed for killing livestock in Texas and wreaking havoc

2025-02-12

The mystery of why farmers had started falling ill in Johnson County, Texas and what killed the fish in their ponds and livestock on their ranches may have been solved. The culprit is claimed to be a fertiliser contaminated with dangerous levels of polyfluoroalkyl and perfluoroalkyl substances (PFAS) that was spread on adjacent farmland, according to the findings of an ongoing criminal investigation.

The case began in late December 2022 when Dana Ames, an environmental crimes investigator for Johnson County, received a complaint from a farmer who said a neighbour was spreading what appeared to be fertiliser that had been smoking for days. He reported that the valley surrounding his property had filled up with smoke, which was creating breathing problems for himself, his wife and neighbours. Further, the farmer alleged that previous spreading of this material by the same neighbour had caused the fish in his pond and other nearby ponds to die and that it had led to his animals becoming ill too.

When Ames arrived on the scene, she observed a dozen or more large, black smouldering piles emitting large plumes of smoke with a smell so pungent that Ames recalls almost vomiting. She reported that the smoke also made it hard for her to breathe. Although it is unclear why the product was smoking, Ames says there are 'a couple of different theories' having to do with microplastics and composting.

Ames observed the product being spread by tractor and quickly discovered that it was a Synagro fertiliser made from biosolids – municipal wastewater-treated sewage sludge from the city of Fort Worth, Texas. She immediately opened an investigation and began collecting samples of soil, pond water, well water, as well as fish and animal tissue, for analysis. The Synagro fertiliser itself was also tested.

Synagro has denied that its fertilisers have harmed the health of farmers or livestock and is contesting the lawsuit.

In a statement, the firm said: 'None of the plaintiffs themselves used Synagro products and the biosolids applied by a farmer working with Synagro met all [US Environmental Protection Agency] and Texas Commission on Environmental Quality requirements. US EPA continues to support land application of biosolids as a valuable practice that recycles

nutrients to farmland and has not suggested that any changes in biosolids management is required.'

'As a matter of fact, without any response from Synagro, the plaintiffs amended the complaint to drastically reduce the concentrations of PFAS alleged in the complaint when it was originally filed,' the company added.

In the two years since the investigation began, Johnson County Commissioner Larry Woolley, a lifelong farmer and rancher with a degree in agriculture, cites reports of hundreds of fish and about 35 cattle and five horses dying that were blamed on PFAS-contaminated biosolids.

Since 2016, more than 866,000 tonnes of sewage sludge has been applied to US farmland, according to an analysis by the Environmental Working Group. The organisation estimates that 5% of all arable land in the US has had fertiliser applied to it that contains PFAS-contaminated biosolids. A recent draft report from the EPA appears to show that high levels of PFAS in sewage sludge applied to farmland can cause cancer and other diseases in those living near farms where it is applied.

PFOS in stillborn calf

Overall, 32 individual PFAS chemicals were identified on the victims' properties, including perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and hexafluoropropylene oxide-dimer acid (HFPO-DA), also known as GenX.

PFAS levels in drinking water wells on the plaintiffs' properties were found to range from 91 nanograms per litre (ng/l) up to 268ng/l and their soils ranged from 97ng/l to about 6291ng/l (1ng/l is equivalent to 1 part per trillion).

Some of the fish and animal tissue results were much higher. A stillborn calf had PFAS levels approaching 1500ng/l and its liver held more than 613,00ng/l of PFAS, the vast majority of which was PFOS. The tissue of another calf that died at a week old held 3200ng/l of PFAS, including 320ng/l of PFOS, though its liver was not tested.

Meanwhile, two fish tested at more than 74,000ng/l and 57,000ng/l of PFOS, respectively. And the actual fertiliser product itself tested at 13,000ng/l of PFOS in about 100g of the product. The source of the PFAS contaminating these biosolids isn't entirely clear, but it is likely to be from runoff entering drains. This wastewater could be contaminated by PFAS-containing firefighting foams, industrial effluent, landfill leachate and other unknown sources.

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Earlier this year, the EPA released long-awaited regulations that set national and enforceable drinking water standards for six PFAS, known as maximum contaminant levels (MCLs), which specified 4ng/l for both PFOA and for PFOS individually, as well as 10ng/l for GenX. The agency also proposed health-based, non-enforceable MCL goals of zero for PFOA and PFOS because 'there is no dose below which either chemical is considered safe'.

Those thresholds are dramatically lower than the non-regulatory 70ng/l lifetime health advisory for drinking water that the EPA established in 2016 for PFOA and PFOS.

Biomagnifying up the food chain

Kyla Bennett, an ecologist who directs science policy for the nonprofit group Public Employees for Environmental Responsibility (Peer) and served as a consultant for the investigation, had previously been involved in a couple of cases involving biosolids and quickly connected the dots. 'When we heard "biosolids", we were like, "Well, we know what's killing all of their animals"', recalls Bennett, a former wetland permit reviewer and wetlands enforcement coordinator at the EPA.

The PFAS contained in the biosolids can seep into the soil, groundwater and surface waters of land treated with this fertiliser. This can contaminate plants grown there, which are then eaten by livestock with the contamination moving up the food chain to people.

'What we think is happening is that all this PFAS leached onto the neighbouring farm – to our clients,' Bennett tells Chemistry World. 'It got into the water – into the stock ponds – and the cows are drinking and swimming in those stock ponds and eating the grass, which is now contaminated with PFAS, and it biomagnifies through the food chain.'

'The PFAS accumulates in larger and larger amounts from soil to vegetation to animals,' she explains, noting that her affected clients have stopped selling their meat since they discovered the contamination.

Besides the criminal investigation that Ames is leading, there are two other related legal cases running in parallel.

Parallel lawsuits

The first involves Peer suing the EPA to force the agency to start regulating PFAS in biosolids under the Clean Water Act (CWA), which would involve prohibiting products from being applied to land if they contain PFAS in

amounts above a certain threshold. The agency moved to dismiss that lawsuit back in September, arguing that the CWA only requires that it review biosolids regulations every two years but not actually identify 'additional toxic pollutants' to be regulated.

The other ongoing case is a liability lawsuit, launched by affected farmers, against Synagro and its Texas affiliate and brought by a private law firm. It seeks financial compensation for the plaintiffs – compensatory and punitive damages of more than $75,000.

'Similar instances of PFAS poisonings of farms, dairies and ranches have occurred in several states,' Bennett stated when announcing that lawsuit in February. She pointed out that Maine outlawed application of biosolids back in April 2022 after more than 60 farms were found to have unsafe levels of PFAS contamination. 'This lawsuit against Synagro will likely be the first of many,' Bennett predicted.

Michigan and Colorado have also put in place regulations requiring their wastewater treatment plants to assess and report the levels of PFAS contamination and control the entry of these chemicals into the wastewater system from major industrial sources.

States are stepping up in the absence of federal action. The EPA has no authority to regulate contaminants like PFAS in biosolids and it currently only requires that they be tested for nine heavy metals and a handful of pathogens.

EPA taking 'far too long'

There is a consensus among many stakeholders about the importance of federal regulation of PFAS in biosolids. 'If we're regulating drinking water to 4[ng/l] then biosolids should be regulated at probably not 4[ng/l], but at some figure not much higher than that,' Woolley states.

Ames agrees. 'When the EPA says that these chemicals are so dangerous that we can't afford to have more than 4[ng/l] in drinking water … can you tell me how in the hell it would be okay to sit down and eat a calf's liver … that has 610,000[ng/l] of PFOS in it?' she asks.

Before they started being applied as fertiliser, biosolids were disposed of in lakes, streams and oceans, contaminating waterways and marine life. Then the CWA, which became law in 1972, allowed application of this organic matter to farmland.

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The EPA has been investigating whether PFAS should be regulated in biosolids for several years now and the agency is taking 'far too long' to act, according to Bennett. 'We're losing farms all across the country,' she says. 'If you look at Maine, they have something like 70-plus impacted farms, and Michigan, Minnesota, New Mexico – everywhere you look – we're finding problems.'

PFAS is ubiquitous in consumer products and these chemicals are not removed during wastewater treatment. In fact, up to 19 times more PFAS are created during this process because some of these chemicals get partially broken down and then recombine and form new PFAS compounds, according to Bennett.

Currently, there are three EPA-approved methods for disposing of biosolids – incineration, landfill and applying them to land. The cheapest option is to sell such products as fertiliser to farmers for anywhere from $30–$40/tonne, Woolley notes.

Meanwhile, the EPA still has no standard definition of PFAS. Bennett argues that the agency should define these chemicals broadly, regulate them as one class, and ban all non-essential uses. 'If they do those three very simple things, then there won't be PFAS in our consumer products and it won't be in the biosolids, and then they can land apply it,' she states.

Legislating for PFAS

In terms of what's next for Johnson County, the legislative session starts in late January, and one of Woolley's goals is to educate county leaders, as well as state representatives and state senators, about the risk of PFAS-contaminated biosolids in fertiliser. He and fellow commissioners are currently working on developing draft legislation to address the issue.

At the state level, Texas state congresswoman-elect Helen Kerwin introduced legislation on 19 December to strictly limit the amount of PFAS chemicals in fertilisers and other agricultural materials. This bill would also require manufacturers to regularly test for, and publicly report, PFAS levels.

There is concern about progress at the national level in the US. Bennett, for example, is not optimistic about the new administration, noting that Project 2025 – a conservative blueprint for a second Trump presidency that was crafted with input from several of the president-elect's former cabinet members – clearly expresses an intent to revisit PFAS regulations and the designation of these chemicals as 'hazardous substances'.

The Republican senator who will chair the Senate Environment and Public Works Committee in the new Congress, Shelley Moore Capito, recently repeated claims that the EPA's new, stricter PFAS drinking water standards are based on questionable science and she suggested that these regulations are too costly for water utilities to implement.

Water utilities and chemical companies are already challenging these rules in court, with the former arguing that they significantly underestimate nationwide compliance costs, and the latter maintaining that the regulations exceed the agency's authority.'The EPA is being sued over the MCLs, and under a Trump EPA I can see them saying, "Yep, you're right, never mind, we'll revisit this"', Bennett states. She notes that these drinking water standards aren't even in effect because the EPA gave public water systems five years – until 2029 – to comply.

PFAS-contaminated biosolids in fertilisers is not just a Johnson County or Texas problem, Bennett emphasises. 'This is a national crisis that is threatening our entire food supply,' she warns. 'We cannot afford to have a state-by-state solution to this problem – we need a federal solution.'

Chemistry World, 12 February 2025

https://chemistryworld.com

How Earth's early cycles shaped the chemistry of life

2025-02-12

A new study explores how complex chemical mixtures change under shifting environmental conditions, shedding light on the prebiotic processes that may have led to life. By exposing organic molecules to repeated wet-dry cycles, researchers observed continuous transformation, selective organization, and synchronized population dynamics.

Their findings, appearing in Nature Chemistry, suggest that environmental factors played a key role in shaping the molecular complexity needed for life to emerge.

To simulate early Earth, the team subjected chemical mixtures to repeated wet-dry cycles. Rather than reacting randomly, the molecules organized themselves, evolved over time, and followed predictable patterns.

This challenges the idea that early chemical evolution was chaotic. Instead, the study suggests that natural environmental fluctuations helped guide the formation of increasingly complex molecules, eventually leading to life's fundamental building blocks.

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The study led by Dr. Moran Frenkel-Pinter, from the Institute of Chemistry at The Hebrew University of Jerusalem, as well as Prof. Loren Williams, from the Georgia Institute of Technology, investigates how chemical mixtures evolve over time, illuminating potential mechanisms that contributed to the emergence of life on Earth.

The research examines how chemical systems can undergo continuous transformation while maintaining structured evolution, offering new insights into the origins of biological complexity.

Chemical evolution refers to the gradual transformation of molecules in prebiotic conditions, a key process in understanding how life may have arisen from non-living matter. While much research has focused on individual chemical reactions that could lead to biological molecules, this study establishes an experimental model to explore how entire chemical systems evolve when exposed to environmental changes.

The researchers used mixtures containing organic molecules with diverse functional groups, including carboxylic acids, amines, thiols, and hydroxyls.

By subjecting these mixtures to repeated wet-dry cycles—conditions that mimic the environmental fluctuations of early Earth—the study identified three key findings: chemical systems can continuously evolve without reaching equilibrium, avoid uncontrolled complexity through selective chemical pathways, and exhibit synchronized population dynamics among different molecular species.

These observations suggest that prebiotic environments may have played an active role in shaping the molecular diversity that eventually led to life.

"This research offers a new perspective on how molecular evolution might have unfolded on early Earth," said Dr. Frenkel-Pinter

"By demonstrating that chemical systems can self-organize and evolve in structured ways, we provide experimental evidence that may help bridge the gap between prebiotic chemistry and the emergence of biological molecules."

Beyond its relevance to origins-of-life research, the study's findings may have broader applications in synthetic biology and nanotechnology. Controlled chemical evolution could be harnessed to design new

molecular systems with specific properties, potentially leading to innovations in materials science, drug development, and biotechnology.

Phys Org, 12 February 2025

https://phys.org

Kimchi and Your Health: The Good and the Bad

2025-01-28

Kimchi is a dietary staple of Korean diets, and for good reason. The fermented cabbage is a well-known probiotic and supposed superfood. Health Magazine once listed it as one of the five healthiest foods in the world, alongside Greek yoghurt and Spanish olive oil.

Its benefits are so touted, one might wonder if kimchi can actually live up to the hype.

Let's take a look at the research to find out.

The good

Kimchi consists of salted and fermented vegetables, typically baechu cabbage, with added garlic, ginger and chili. This fermentation process is carried out by lactic acid bacteria (LABs) like Leuconostoc, Lactobacillus and Weissella. Many of these LABs are considered probiotics, which are known to benefit the human gut microbiome and have even been linked to weight loss.

Published in 2020, one trial of 114 adults found that, after 12 weeks of either taking kimchi-derived probiotic supplements or placebos, the kimchi-consuming participants lost, on average, 0.2 kg of fat mass while the placebo group gained, on average, 0.6 kg of fat mass. The kimchi group also had significantly slimmer waist circumferences by the end of the study.

There's evidence that kimchi's beneficial bacteria also combat harmful bacteria present in the human gut. Published in 2016, one controlled clinical trial found that, compared to the 6 women who were fed 15 g of kimchi per day, the 6 women who consumed 150 g a day showed a notable decrease in potentially harmful bacteria like Listeria and Clostridium.

Another study published in 2021 made similar findings. After eating 100 g of kimchi every day for 10 weeks, 32 people experienced a dramatic reduction of the "bad" gut bacteria Helicobacter pylori. In several cases, the

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bacteria seemed to have been eliminated from the participants' guts by the end of the trial.

Elsewhere in the body, kimchi's fat-fighting qualities are most apparent in the blood.

Published in 2013, another trial comparing the effects of high and low kimchi consumption found that a higher intake improved serum lipid profiles and fasting glucose levels. Both portion sizes lowered concentrations of total glucose, total cholesterol and low-density lipoprotein (or LDL, often dubbed the "bad" cholesterol).

Published in 2018, another trial of high kimchi consumption (210 g/day) found that the Korean side dish seemed to significantly improve body fat percentage and skeletal muscle mass. The participants' levels of beneficial bacteria like Faecalibacterium and Bifidobacterium also increased by the end of the trial while levels of harmful bacteria like Clostridium and Escherichia coli fell.

Beyond its effect on obesity, kimchi may also have benefits for people living with irritable bowel syndrome. Published in 2022, one trial of 90 participants with the condition found that three varieties of kimchi all had significant improvements in abdominal pain or inconvenience, desperation, incomplete evacuation and bloating.

Even those without irritable bowel syndrome have reported gastrointestinal benefits after adding kimchi into their diets. Published in 2019, one trial found that, after eating 75 g of kimchi twice each day for 14 days, the 20 participants with a history of digestive problems felt a significant reduction in their abdominal pain, heartburn, acid reflux, bloating and belching.

The bad

Not everyone who eats kimchi experiences such gastrointestinal improvements, though. Indeed, for a minority of people, the Korean cabbage dish can seemingly cause and worsen symptoms like bloating.

The same 2020 study that evidenced kimchi's fat-fighting qualities, for instance, also noted that some participants experienced adverse gastrointestinal discomfort, although these symptoms were mild.

Bloating is a common reaction to all kinds of fermented foods due to the temporary increase in gas caused by the probiotic bacteria killing harmful gut bacteria.

Fermented foods like kimchi also naturally contain biogenic amines, like histamines, which are created by certain bacteria to break down the amino acids in fermented foods. Because amines stimulate the central nervous system, the compounds can increase or decrease blood flow, which can trigger headaches and migraines in some people with histamine intolerance. Other symptoms of histamine intolerance include itching, runny nose, fatigue, hives and digestive symptoms including diarrhea, nausea and vomiting.

If not fermented or stored properly, kimchi can also pose a food poisoning risk. In 2013 and 2014, two large outbreaks of E. coli in South Korean schools were respectively associated with contaminated kimchi.

Lastly, while kimchi's health boons are undeniable, some positive findings from certain studies have occasionally been called into question by others.

For instance, though a 2021 study found that kimchi reduces and even eliminates levels of the harmful bacteria H. pylori in the gut, one study published in 2004 found that participants still had H. pylori four weeks into a high-kimchi diet. It's worth noting, however, that the 2021 study was conducted over a long period of time, 10 weeks.

Another study, published in 2020, added some nuance to kimchi's bowel benefits. In a trial involving rectal cancer patients, the researchers found no significant effect of kimchi-derived probiotics in comparison with a placebo.

Final thoughts

Thanks to its probiotic contents, kimchi is a healthy, gut-boosting side dish that can, if eaten regularly, even help consumers lose excess weight. Reductions in gastrointestinal symptoms like bloating and abdominal pain are also possible, though the food might also cause the same symptoms in individuals with susceptibilities like histamine intolerance.

Technology Networks, 28 January 2025

https://technologynetworks.com

A fungus named after Sir David Attenborough zombifies cave spiders

2025-02-10

A newly discovered fungus — named after naturalist Sir David Attenborough — transforms cave spiders into zombies. The species

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(Gibellula attenboroughii) forces reclusive arachnids into exposed areas, likely to benefit the dispersal of spores, researchers report January 24 in Fungal Systematics and Evolution.

The freaky fungus was first spotted on an orb-weaving spider (Metellina merianae) by a team filming a BBC documentary series in Northern Ireland in 2021. (It was also later found in the Republic of Ireland.) Researchers in the United Kingdom teamed up with mycologist João Araújo of the Natural History Museum of Denmark in Copenhagen to learn more about the fungus.

The Gibellula genus of fungi are spider specialists, Araújo says. Scientists believe that after a spore lands on a spider, the fungal cell sinks into the body and multiplies, consuming its host's internal organs. "If we cut through the infected spider, we don't see any spider anymore," he says. "It's just the fungal mass inside, which is the shape of the spider." Fruiting bodies shaped like lollipops also emerge to spread spores to new hosts.

To investigate whether the documentary's grotesque fungal guest was a new species, Araújo and colleagues considered its ecology, shape and genetics. This was the first known Gibellula found in cave spiders, showing it occupies a unique niche, Araújo says. Additionally, physical characteristics of the fungus's structures, such as the fruiting bodies and spore-producing cells, and distinctions in its DNA suggested the species stood out.

Moreover, G. attenboroughii–infected cave spiders, which also include Meta menardi, typically hide away in their webs, Araújo notes. Because the zombified spiders traveled to cave entrances before dying, he and his colleagues hypothesize that the fungus drove the arachnids there because the airflow helps to disperse spores. The behavioral change resembles that seen in fungus-infected ants.

Besides being a bewitching example of a parasite-host relationship — a video narrated by Attenborough sparked Araújo's fascination with zombifying fungi — researching this association has practical applications, too. These fungi could aid pest control in crops and lead to medical innovations, Araújo says. Cyclosporine, for example, is a drug with origins in a zombifying fungus that helps prevent rejection of transplanted organs.

Building that knowledge base requires studying fungal species one by one, he adds. "Maybe today, there's not an immediate application. But

maybe someday, after all these pieces are put together, we can figure out something bigger."

Science News, 10 February 2025

https://sciencenews.org

Click chemistry method advances drug development with improved triazole synthesis

2025-02-11

Middle molecules with a molecular weight of more than 1,000 are difficult to synthesize due to multiple steps and time-consuming nature, demanding the development of a new approach that can overcome these disadvantages.

Click chemistry has become an essential tool in applied chemistry due to its simplicity, efficiency, and versatility. This approach to chemical synthesis allows for quick and reliable joining of small molecules into larger, more complex structures, often with minimal side reactions and byproducts.

By definition, click chemistry reactions are highly selective and efficient, making them ideal for creating specific compounds in a controlled and predictable manner.

By taking this idea two steps further, chemists have been developing molecular platforms that allow for triple click chemistry—the development of stable molecules with three different functional groups that serve as distinct, targetable reaction sites.

Although these "trivalent" platforms enable the efficient synthesis of complex compounds, the selective formation of triazoles using platforms with azide and alkyne moieties remains an unsolved challenge.

Against this backdrop, a research team led by Associate Professor Suguru Yoshida from Tokyo University of Science (TUS), Japan, set out to develop novel trivalent platforms capable of producing highly functional triazoles.

The team ensured coordination with the United Nations' sustainable development goals (SDGs)—SDG 3 (good health and well-being), SDG 7 (affordable and clean energy), and SDG 9 (industry, innovation and infrastructure).

The study, which was published in Chemical Communications on January 7, 2025, was co-authored by Mr. Takahiro Yasuda, a master's degree student, and Mr. Gaku Orimoto, who completed a master's degree in 2023, both from TUS.

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The researchers succeeded in creating stable trivalent platforms for triple click chemistry, thanks to a longer linker in the central scaffold. The research team demonstrated how a wide variety of molecules could be produced by sequentially targeting each functional moiety in the trivalent platform.

For example, they leveraged the sulfur–fluoride exchange reaction to target the fluorosulfonyl moiety and produce different alcohols at high yields without affecting the azide and alkyne moieties.

Then, they performed diverse transformations on the azide moiety, including hallmarks like copper-catalyzed azide–alkyne cycloaddition, strain-promoted azide-alkyne cycloaddition, and Bertozzi–Staudinger ligation.

Finally, through a broad range of possible third transformations targeting the remaining alkyne moiety, the researchers successfully synthesized complex triazoles.

Notably, it was not strictly necessary to follow the order described above when targeting each moiety, as the researchers demonstrated triazole formations selectively in subsequent experiments. On top of this, complex triazoles could be obtained in a straightforward, one-pot reaction.

"Selective click reactions with molecules that have both azide and alkyne moieties are not easy, but we were able to elucidate that each click reaction proceeds in a highly selective manner by properly choosing alkyne or azide reaction partners that react preferentially with the targeted group under the suitable conditions," explains Yoshida.

The triple click chemistry platforms developed in this study have important implications in several applied fields. For example, functionalized multi-triazoles, which can be readily prepared at high yield, are valuable in drug development, material science, and bioengineering. They are compatible with many biological targets, such as enzymes and receptors, indicating potential pharmaceutical applications.

The bio-active middle molecules synthesized via triple click chemistry can help in recovering from intractable diseases. Moreover, they are important in catalysis and materials development, serving as the basis for the design of polymers, sensors, coatings, and coordination frameworks.

"Our ultimate goal is to create new molecules that will revolutionize life sciences, and we conceived this research as a method for assembling simple component molecules all at once," concludes Yoshida.

"The proposed method enables the simple synthesis of multifunctional molecules and a wide variety of medium-sized molecules, and we expect it to be widely useful in pharmaceutical science, medicinal chemistry, chemical biology, and materials chemistry."

The proposed approach utilizes simple initial materials rather than complex materials, promoting sustainable pharmaceutical synthesis. Additionally, the time-saving aspect of this approach can speed up the research process.

Overall, the efficient trivalent platform molecules presented in this study will help accelerate progress toward more sustainable chemistry, hopefully leading to green synthesis protocols, better medical treatments, and environmental and agricultural advancements.

Phys Org, 11 February 2025

https://phys.org

Breast cancer treatment advances with light-activated 'smart bomb'

2025-02-11

Scientists have developed new light-sensitive chemicals that can radically improve the treatment of aggressive cancers with minimal side effects. In mouse tests, the new therapy completely eradicated metastatic breast cancer tumors.

The novel chemicals, called cyanine-carborane salts, and their role in the next-generation of cancer treatments, are described in a new article published in Angewandte Chemie, a journal of the German Chemical Society.

Photodynamic therapy, or PDT, has been used for decades to treat forms of skin and bladder cancers. It works by flooding a patient's body with light-sensitive chemicals that accumulate in cancer cells. Shining a light on the patient activates the chemicals and kills the diseased cells.

The light causes the chemicals to generate highly reactive oxygen molecules -- like tiny biochemical firecrackers -- that break down cancer cells from the inside while leaving healthy cells unharmed.

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It is a useful therapy with several drawbacks that limit its effectiveness, including prolonged light sensitivity, poor tissue penetration and off-target toxicity. These drawbacks can prevent complete tumor eradication and may lead to a recurrence of the cancer.

The multidisciplinary research team is composed of scientists from University of California, Riverside and Michigan State University, or MSU.

"Cyanine-carborane salts minimize these challenges, offering a safer, more precise way to destroy tumors completely while sparing healthy tissue," said Professor Sophia Lunt, MSU cancer researcher and co-principal investigator of the project.

The researchers said current FDA-approved PDT chemicals remain in the body for extended periods of time. After treatment, patients have to stay in the dark for two to three months because even low levels of light will cause them to become blistered and burned.

In contrast, the researchers found that cyanine-carborane salts flush out of the body more quickly, remaining only in the cancer cells requiring treatment.

Vincent Lavallo, UCR chemistry professor and co-prinicipal investigator, is an expert on the synthesis of carboranes.

"The most interesting thing is the targeting ability of this substance we made to go right where it's needed and stay there while the rest passes through. That way you'll only kill the cells right where the cancer is but not harm the patient," Lavallo said.

Lavallo worked together with Richard Lunt, MSU endowed professor of chemical engineering, to develop the cyanine-carborane salts.

Unlike conventional PDT agents, the salts exploit a natural vulnerability in cancer cells. They're taken up by proteins called OATPs that are overexpressed in tumors. This allows for precise targeting without the need for costly additional chemicals currently used with PDT to help target the cancer cells.

Traditional PDT is also limited in its ability to treat deep-seated tumors because it works with wavelengths of light that only penetrate a few millimeters into the body. Once inside cancer cells, cyanine-carborane salts can be activated by near-infrared light that is able to move deeper into tissues. This could expand the range of cancers that could be treated.

Given their success, researchers are encouraged to continue the research and try to expand the types of cancer therapies the salts can be used with. It may be possible to alter the salts so that they can be used with energy sources other than light that penetrate even more deeply into the body.

"Our work offers a targeted, safe, and cost-effective treatment for aggressive breast cancers with limited treatment options," said Amir Roshanzadeh, paper first author and MSU cell & molecular biology graduate student. "It also opens the door to breakthroughs in other approaches for cancer therapy and targeted drug delivery."

Science Daily, 11 February 2025

https://sciencedaily.com

AI program could help tackle global microplastics challenge

2025-02-11

Monash researchers have developed a novel AI program to assist scientists in the global fight against the scourge of environmental microplastics. The research is published in the Journal of Hazardous Materials.

Despite making headlines in recent years, a lot of scientists and policymakers still don't know about the scale of the issue, including exactly what kind of microplastics are out there and where they are ending up.

The program developed by Monash uses sophisticated machine learning algorithms to analyze thousands of samples in fractions of a second—a process that can take months for humans—to gain a crucial understanding of where and how we need to act.

It's not as simple as putting the sample under a microscope, because appearance alone can be misleading.

For example, natural materials like tiny pieces of seashells can often look like microplastics.

The new algorithm instead uses the chemical components that make up those materials to identify characteristic "signatures" (complex numerical figures, many thousands of characters long) that can accurately identify known microplastic types, using data from a process called Fourier transform infrared spectroscopy (FTIR).

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Crucially, the program is the first in the world capable of analyzing a library of microplastics signatures, something desperately needed by researchers grappling with the mammoth task of addressing the issue.

The breakthrough was pioneered by lead researcher Frithjof Herb, a Monash University Ph.D. candidate, and supervisor Dr. Khay Fong, Senior Lecturer in the Monash School of Chemistry.

"We are addressing a significant bottleneck for progress in tackling the microplastics problem," Herb said. "Not only is the process of analyzing samples arduous and time consuming, but until now, we have been unable to do it on a large enough scale to gain a comprehensive understanding of exactly what microplastics we are dealing with, where they are, and where they end up.

"This is a very important first step in finding ways that we can clean up these damaging microplastics, and find ways to prevent them from entering environmental waterways in the first place."

In addition to seashells, other natural fibers commonly mistaken for microplastics include algae, animal fur or crustacean shells.

Herb said the evolution of human-made materials also complicates things, with chemical components of microplastics constantly changing.

"Plastics are constantly changing, both in how they're made and how they break down in the environment. Traditional tools struggle to keep up with these changes," he said. "But our tool offers a crucial advantage to scientists who need something that can quickly adapt, which is important for analyzing data that continues to evolve.

"We are really proud of what we have achieved here; it runs nicely on conventional laptops, reflecting our focus on sustainability and accessibility, which we sought through small and efficient models."

Phys Org, 11 February 2025

https://phys.org

Gold outperforms Ozempic for weight loss – and leaves muscles alone

2025-02-10

There's a growing body of evidence that gold nanoparticles can offer significant, targeted weight loss that focuses on fat (lipid) tissue, without affecting muscle structure. What's more, there are added health bonuses, including anti-inflammatory properties and improvements in blood glucose levels.

Scientists from Egypt's Alexandria University have furthered what we know about gold nanoparticles (AuNPs), demonstrating that weekly doses have the potential to lead to significant weight loss – perhaps even more than the GLP-1 class of medications – and, unlike those drugs, showed no evidence of muscle wastage.

But, there is a catch. The numbers are impressive – 36% targeted fat loss over nine weeks, compared to the typical 10-20% reduction of body weight seen in those taking GLP-1 drugs (with up to 20% of that being muscle loss) – yet so far the scientists have only conducted animal studies. This research, however, gets the novel obesity treatment a step closer to a human trial.

In the rat study, the researchers compared different doses of AuNPs, with a control (no treatment) and existing weight-loss drug orlistat (brand name Xenical). The diet-induced obese rats were assigned one of these treatment groups and treated for nine weeks, after which their body composition, organ health and metabolic markers were assessed.

What they found was that high weekly doses of AuNPs significantly reduded body fat, increased muscle mass and boosted metabolic markers in obese animals. Like in previous studies, there was also evidence of improved blood sugar levels, and reduced inflammation and oxidative stress. Histological assessment also revealed that AuNPs repaired liver and kidney tissue – while orlistat adversely affected these organs.

Through bioelectrical impedance analysis (BIA), a common non-invasive method of measuring the body's fat mass (FM), fat-free mass (FFM) and total body water (TBW), the researchers found that AuNPs were also able to target the right lipid cells. The high weekly dose group saw an average of 36% fat loss, which was more effective than daily high doses (33%), and significantly better than the rats on orlistat (18%). Essentially, twice as impactful.

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"BIA and dissection measurements of body-composition showed that high doses of AuNPs treatment significantly lowered body fat and improved fat-free mass, making it a potential alternative to current obesity treatments," the researchers noted. "While earlier studies have shown that orlistat can reduce obesity-related weight gain, AuNPs are a more effective anti-obesity treatment due to their anti-inflammatory and antioxidant effects, as well as their ability to accumulate in adipose tissues."

In a world where GLP-1 drugs exist, it can be easy to forget that there are other medications out there, such as orlistat. It's also nothing like Wegovy or Ozempic, instead helping block the role of lipid (fat) absorption. While results are more modest long-term than GLP-1 medications – individuals lose around 6% of their body weight – it's a significantly cheaper option and an alternative to those who encounter serious side effects from GLP-1s.

There has been no comparison of GLP-1s and AuNPs, however, but given the latter's evidence of muscle protection, it has the potential to be a complementary treatment, not a replacement or direct competitor.

AuNPs have been the focus of a lot of attention over the last decade, and there's a growing interest in unlocking its weight-loss potential. The latest research builds on earlier findings, covered in these 2018 and 2023 studies. AuNPs are currently used in various treatments, such as cancer therapy and in drug delivery, but a human obesity trial remains elusive. This is largely due to health unknowns – such as the potential toxicity of AuNPs.

"Since an estimated 60% of the world's population may be overweight or obese by 2030, we urgently need innovative therapies for obesity," the researchers added. "Although AuNPs show promise as an obesity treatment, more research is required to decide whether these particles pose a risk to human organs."

The study was published in the journal Science Reports.

Source: Alexandria University via Nature

New Altas, 10 February 2025

https://newatlas.com

Gut Microbiome Alters Brain Chemistry Through Sugar-Based Protein Changes

2025-02-10

Our guts are home to trillions of bacteria, and research over the last few decades has established how essential they are to our physiology – in health and disease.

A new study from EMBL Heidelberg researchers shows that gut bacteria can bring about profound molecular changes in one of our most critical organs – the brain.

The new study, published in the journal Nature Structural and Molecular Biology, is the first to show that bacteria living in the gut can influence how proteins in the brain are modified by carbohydrates – a process called glycosylation. The study was made possible by a new method the scientists developed – DQGlyco – which allows them to study glycosylation at a much higher scale and resolution than previous studies.

A new way to measure glycosylation

Proteins are the workhorses of our cells and their main building blocks. Sugars, or carbohydrates, on the other hand, are among the body's main sources of energy. However, the cell also uses sugars to chemically modify proteins, altering their functions. This is called glycosylation.

"Glycosylation can affect how cells attach to each other (adhesion), how they move (motility), and even how they talk to one another (communication)," explained Clément Potel, first author of the study and Savitski Team Research Scientist. "It is involved in the pathogenesis of several diseases, including cancer and neuronal disorders."

However, glycosylation has traditionally been notoriously difficult to study. Only a small portion of proteins in the cell are glycosylated and concentrating enough of them in a sample for studying (a process called 'enriching') tends to be laborious, expensive, and time-consuming.

"So far, it's not been possible to do such studies on a systematic scale, in a quantitative fashion, and with high reproducibility," said Mikhail Savitski, Team Leader, Senior Scientist, and Head of the Proteomics Core Facility at EMBL Heidelberg. "These are the challenges we managed to overcome with the new method."

DQGlyco uses easily available and low-cost laboratory materials, such as functionalised silica beads, to selectively enrich glycosylated proteins from

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biological samples, which can then be precisely identified and measured. Applying the method to brain tissue samples from mice, the researchers could identify over 150,000 glycosylated forms of proteins ('proteoforms'), an increase of over 25-fold compared to previous studies.

The quantitative nature of the new method means that researchers can compare and measure differences between samples from different tissues, cell lines, species etc. This also allows them to study the pattern of 'microheterogeneity' – the phenomenon where the same part of a protein can be modified by many (sometimes hundreds of) different sugar groups.

One of the most common examples of microheterogeneity is human blood groups, where the presence of different sugar groups on proteins in red blood cells determines blood type (A, B, O, and AB). This plays a major role in deciding the success of blood transfusions from one individual to the other.

The new method allowed the team to identify such microheterogeneity across hundreds of protein sites. "I think the widespread prevalence of microheterogeneity is something people had always assumed but that had never been clearly demonstrated, since you need to have enough coverage of glycosylated proteins to be able to make the statement," said Mira Burtscher, another first author of the study and a Savitski Team PhD student.

From the gut to the brain

Given the method's precision and power, the researchers decided to use it to address an outstanding biological question. In collaboration with Michael Zimmermann's group at EMBL, they next tested whether the gut microbiome had any effect on the glycosylation signatures they had observed in the brain. Both Zimmermann and Savitski are part of the Microbial Ecosystems Transversal Theme at EMBL, which was introduced by the 2022-26 EMBL programme 'Molecules to Ecosystems'.

"It is known that gut microbiomes can affect neural functions, but the molecular details are largely unknown," said Potel. "Glycosylation is implicated in many processes, such as neurotransmission and axon guidance, so we wanted to test if this was a mechanism by which gut bacteria influenced molecular pathways in the brain."

Interestingly, the team found that when compared to 'germ-free mice', i.e. mice grown in a sterile environment such that they completely lack any microbes in and on their body, mice colonised with different gut bacteria

had different glycosylation patterns in the brain. The changed patterns were particularly apparent in proteins known to be important in neural functions, such as cognitive processing and axon growth.

The study's datasets are openly available via a new dedicated app for other researchers. In addition, the team is also curious whether the data can be used to inform predictions about glycosylation sites, especially in different species. For this, they have been using machine learning approaches such as AlphaFold – the AI-based tool for predicting protein structures recognised with the 2024 Nobel Prize in Chemistry.

"By training the models on mouse data, we can start predicting what could be the variability of glycosylation sites in humans, for example," said Martin Garrido, a postdoc in the Savitski and Saez-Rodriguez groups at EMBL and another first author of the study. "It could be very useful for people studying other organisms to help them identify glycosylation sites in their proteins of interest."

The researchers are also working towards applying the new method to answer more fundamental biological questions and to understand the functional role glycosylation plays in cells.

Technology Networks, 10 February 2025

https://technologynetworks.com

Breakthrough in click chemistry: Innovative method revolutionizes drug development

2025-02-11

Middle molecules with a molecular weight of more than 1,000 are difficult to synthesize due to multiple steps and time-consuming nature, demanding the development of a new approach that can overcome these disadvantages. Click chemistry has become an essential tool in applied chemistry due to its simplicity, efficiency, and versatility. This approach to chemical synthesis allows for quick and reliable joining of small molecules into larger, more complex structures, often with minimal side reactions and byproducts. By definition, click chemistry reactions are highly selective and efficient, making them ideal for creating specific compounds in a controlled and predictable manner.

By taking this idea two steps further, chemists have been developing molecular platforms that allow for triple click chemistry -- the development of stable molecules with three different functional groups

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that serve as distinct, targetable reaction sites. Although these "trivalent" platforms enable the efficient synthesis of complex compounds, the selective formation of triazoles using platforms with azide and alkyne moieties remains an unsolved challenge.

Against this backdrop, a research team led by Associate Professor Suguru Yoshida from Tokyo University of Science (TUS), Japan, set out to develop novel trivalent platforms capable of producing highly functional triazoles. The team ensured coordination with the United Nations' sustainable development goals (SDGs) -- SDG 3 (good health and wellbeing), SDG 7 (affordable and clean energy), and SDG 9 (industry, innovation and infrastructure). This study, which was published in Chemical Communications on January 7, 2025, was co-authored by Mr. Takahiro Yasuda, a master's degree student, and Mr. Gaku Orimoto, who completed a master's degree in 2023, both from TUS.

The researchers succeeded in creating stable trivalent platforms for triple click chemistry, thanks to a longer linker in the central scaffold. The research team demonstrated how a wide variety of molecules could be produced by sequentially targeting each functional moiety in the trivalent platform. For example, they leveraged the sulfur-fluoride exchange reaction to target the fluorosulfonyl moiety and produce different alcohols in high yields without affecting the azide and alkyne moieties. Then, they performed diverse transformations on the azide moiety, including hallmarks like copper-catalyzed azide-alkyne cycloaddition, strain-promoted azide-alkyne cycloaddition, and Bertozzi-Staudinger ligation. Finally, through a broad range of possible third transformations targeting the remaining alkyne moiety, the researchers successfully synthesized complex triazoles.

Notably, it was not strictly necessary to follow the order described above when targeting each moiety, as the researchers demonstrated triazole formations selectively in subsequent experiments. On top of this, complex triazoles could be obtained in a straightforward, one-pot reaction. "Selective click reactions with molecules that have both azide and alkyne moieties are not easy, but we were able to elucidate that each click reaction proceeds in a highly selective manner by properly choosing alkyne or azide reaction partners that react preferentially with the targeted group under the suitable conditions," explains Yoshida.

The triple click chemistry platforms developed in this study have important implications in several applied fields. For example, functionalized multi-triazoles, which can be readily prepared in high yield,

are valuable in drug development, material science, and bioengineering. They are compatible with many biological targets, such as enzymes and receptors, indicating potential pharmaceutical applications. The bio-active middle molecules synthesized via triple click chemistry can help in recovering from intractable diseases. Moreover, they are important in catalysis and materials development, serving as the basis for the design of polymers, sensors, coatings, and coordination frameworks.

"Our ultimate goal is to create new molecules that will revolutionize life sciences, and we conceived this research as a method for assembling simple component molecules all at once," concludes Yoshida. "The proposed method enables the simple synthesis of multifunctional molecules and a wide variety of medium-sized molecules, and we expect it to be widely useful in pharmaceutical science, medicinal chemistry, chemical biology, and materials chemistry."

The proposed approach utilizes simple initial materials rather than complex materials, promoting sustainable pharmaceutical synthesis. Additionally, the time-saving aspect of this approach can speed up the research process. Overall, the efficient trivalent platform molecules presented in this study will help accelerate progress toward more sustainable chemistry, hopefully leading to green synthesis protocols, better medical treatments, and environmental and agricultural advancements.

Science Daily, 11 February 2025

https://sciencedaily.com

"Molecular Cage" Could Help Remove Drugs and Chemical Pollutants From Water

2025-02-10

Researchers have developed a new material that could help to remove unwanted pollutants — including leftover medicines and synthetic chemicals — from our waterways.

The metal-organic cage (MOC) molecules are designed to absorb harmful pollutants and trap them inside their cage-like structures. While MOCs have been used previously for gas and chemical capture in organic solvents, this latest research introduces a rare water-soluble MOC made with an easily adaptable synthesis technique. The research is published in Cell Reports Physical Sciences.

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Removing harmful contaminants from water

Unmetabolized medications and chemicals left over from hygiene and personal care products have become of increasing concern in recent years. Studies suggest that these compounds could pose a danger to animal health and welfare when present as environmental contaminants.

"While domestic wastewater passes through wastewater treatment plants, these plants frequently do not meet the capacity or the level of chemical purification required to completely prevent medicinal and healthcare products reaching our ecosystems," senior study author Dr. Imogen Riddell, a Royal Society University Research Fellow at the University of Manchester, told Technology Networks.

"Once introduced into natural waterways, these chemicals bioaccumulate in the fatty tissues of aquatic organisms resulting in toxicity and negative effects on the physiology, development and reproduction of the organisms that consume them."

In search of better treatment options that can selectively bind to and remove these contaminants, researchers have turned to MOCs. These cage-like molecules have previously been used to encapsulate, store and release pollutants — such as the potent greenhouse gas SF6 — but have rarely been applied to water-based systems.

"A longstanding challenge in the MOC community has been to design useful MOCs which are also water-soluble. This has been difficult because MOCs often include organic linkers which have poor solubility in water," explained first author Jack Wright, a PhD student in Riddell's research group at the University of Manchester. "Strategies that allow the introduction of water-solubilizing groups, which might address this challenge, often negatively impact the self-assembly of the MOCs themselves."

To make their MOC water-soluble, the researchers incorporated sulfonates into their MOC's structure. Sulfonate-based ligands have good solubility in water, however their poor commercial availability has previously limited their use in water-soluble MOCs. In their new paper, the researchers demonstrate an alternative synthesis technique, based on a simple ring-opening addition reaction, that more easily introduces sulfonate moieties into ligands for water-soluble MOCs.

How do metal-organic cages work?

MOCs are made up of metal ions linked together by organic molecules, leaving a hollow core where other compounds can be trapped. This trapping occurs through an effect known as "hydrophobic binding".

"Effectively what is happening upon binding in our cage is that the oil-like, water-hating (hydrophobic) pollutants are preferentially located inside of our MOC, where they are protected from the repulsion of the water molecules. At the same time, water molecules prefer to be outside the internal binding space than trapped inside it and they are therefore readily displaced by the incoming pollutants," Riddell explained.

To demonstrate the effectiveness of their new MOC at trapping environmental contaminants, the researchers conducted a series of host binding studies using a number of potential water contaminants, including hormone medications and hygiene product chemicals.

"Ethinylestradiol is the synthetic derivative of the naturally occurring molecule estradiol, which is commonly used in female contraceptives," Riddell explained. "Ethinylestradiol has been shown to make its way into our waterways through the excretion of prescribed supplements into domestic wastewater. Once there, it has been implicated in the feminization of fish, which is when male fish change their gender due to external chemical stimuli."

"Similarly, tonalide – a ubiquitous synthetic chemical found in fragrances, laundry products and soaps – has been shown to enter into waterways through everyday human behavior," Riddell said. "Tonalide is highly toxic and is implicated in physiological changes as well as reproductive and developmental problems."

Analysis by NMR spectroscopy indicated that the new MOC was able to capture estradiol, ethinylestradiol, testosterone, progesterone, tonalide and cholesterol in its internal cavity.

"Future efforts will focus on the development of robust and efficient recycling protocols for this MOC system," Riddell said. "We believe that a promising approach would involve the development of an immobilized version of the MOC, which would allow extraction of pollutants from a stream of wastewater which is flown over the MOC. The MOC could then be emptied/regenerated by flowing an organic solvent over it – which would bind the pollutants preferentially."

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"In addition to developing a robust recycling protocol enabling reuse of the MOC, we are interested to make new MOCs with different sized binding pockets which would allow for capture of a wider variety of guest molecules. We also want to further probe the fundamental design rules of these MOCs which would allow us to design new MOCs with specific functions, maximizing their utility and potentially opening up new application areas for this exciting class of molecule."

Technology Networks, 10 February 2025

https://technologynetworks.com

Liquid metal can mimic white blood cell behavior, including shape-shifting and obstacle navigation

2025-02-12

Scientists led by Prof. Liu Jing from the Technical Institute of Physics and Chemistry of the Chinese Academy of Sciences (CAS) have created a leukocyte-like liquid metallic entity that vividly simulates various leukocyte behaviors in nature.

In an article published in the journal Matter on February 10, the researchers demonstrated how these "liquid metallic leukocytes" can autonomously perform complex actions such as engulfing foreign substances, changing shape, moving in a pulsatile manner, and even climbing against gravity—showing striking similarities to the dynamic behavior of living cells.

The research team, collaborating with Tsinghua University, introduced a novel approach by combining the mechanisms of chemotaxis and asymmetric chemistry. This synergy enables the liquid metal to exhibit diverse and autonomous behaviors similar to those of real leukocytes, such as shape-shifting and navigating complex surfaces.

According to the researchers, these liquid metallic structures can climb slopes of up to 5° on their own and move through complicated surfaces, highlighting their versatility and potential for future applications. In addition, they can change their shape easily and adapt well to getting around obstacles, making them highly versatile and capable.

The core principle is that the self-adaptive surface tension of the liquid metal continuously changes during its alternating processes of oxidation, reduction, and deoxidation. Experiments also confirmed that the liquid metal leukocyte relies on substance conversion and electrochemical

energy differences in its environment, enabling it to move and respond dynamically.

This chemotaxic liquid metallic system shows great potential for diverse applications, including autonomous adaptable sensors, microfluidics, and medical therapies. Furthermore, it opens new avenues for developing advanced nature-simulation systems that mimic various living organisms, marking the beginning of a new frontier at the intersection of materials science and synthetic biology.

Phys Org, 12 February 2025

https://phys.org

PFAS in fertilisers blamed for killing livestock in Texas and wreaking havoc

2025-02-12

The mystery of why farmers had started falling ill in Johnson County, Texas and what killed the fish in their ponds and livestock on their ranches may have been solved. The culprit is claimed to be a fertiliser contaminated with dangerous levels of polyfluoroalkyl and perfluoroalkyl substances (PFAS) that was spread on adjacent farmland, according to the findings of an ongoing criminal investigation.

The case began in late December 2022 when Dana Ames, an environmental crimes investigator for Johnson County, received a complaint from a farmer who said a neighbour was spreading what appeared to be fertiliser that had been smoking for days. He reported that the valley surrounding his property had filled up with smoke, which was creating breathing problems for himself, his wife and neighbours. Further, the farmer alleged that previous spreading of this material by the same neighbour had caused the fish in his pond and other nearby ponds to die and that it had led to his animals becoming ill too.

When Ames arrived on the scene, she observed a dozen or more large, black smouldering piles emitting large plumes of smoke with a smell so pungent that Ames recalls almost vomiting. She reported that the smoke also made it hard for her to breathe. Although it is unclear why the product was smoking, Ames says there are 'a couple of different theories' having to do with microplastics and composting.

Ames observed the product being spread by tractor and quickly discovered that it was a Synagro fertiliser made from biosolids – municipal

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wastewater-treated sewage sludge from the city of Fort Worth, Texas. She immediately opened an investigation and began collecting samples of soil, pond water, well water, as well as fish and animal tissue, for analysis. The Synagro fertiliser itself was also tested.

Synagro has denied that its fertilisers have harmed the health of farmers or livestock and is contesting the lawsuit.

In a statement, the firm said: 'None of the plaintiffs themselves used Synagro products and the biosolids applied by a farmer working with Synagro met all [US Environmental Protection Agency] and Texas Commission on Environmental Quality requirements. US EPA continues to support land application of biosolids as a valuable practice that recycles nutrients to farmland and has not suggested that any changes in biosolids management is required.'

'As a matter of fact, without any response from Synagro, the plaintiffs amended the complaint to drastically reduce the concentrations of PFAS alleged in the complaint when it was originally filed,' the company added.

In the two years since the investigation began, Johnson County Commissioner Larry Woolley, a lifelong farmer and rancher with a degree in agriculture, cites reports of hundreds of fish and about 35 cattle and five horses dying that were blamed on PFAS-contaminated biosolids.

Since 2016, more than 866,000 tonnes of sewage sludge has been applied to US farmland, according to an analysis by the Environmental Working Group. The organisation estimates that 5% of all arable land in the US has had fertiliser applied to it that contains PFAS-contaminated biosolids. A recent draft report from the EPA appears to show that high levels of PFAS in sewage sludge applied to farmland can cause cancer and other diseases in those living near farms where it is applied.

PFOS in stillborn calf

Overall, 32 individual PFAS chemicals were identified on the victims' properties, including perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and hexafluoropropylene oxide-dimer acid (HFPO-DA), also known as GenX.

PFAS levels in drinking water wells on the plaintiffs' properties were found to range from 91 nanograms per litre (ng/l) up to 268ng/l and their soils ranged from 97ng/l to about 6291ng/l (1ng/l is equivalent to 1 part per trillion).

Some of the fish and animal tissue results were much higher. A stillborn calf had PFAS levels approaching 1500ng/l and its liver held more than 613,00ng/l of PFAS, the vast majority of which was PFOS. The tissue of another calf that died at a week old held 3200ng/l of PFAS, including 320ng/l of PFOS, though its liver was not tested.

Meanwhile, two fish tested at more than 74,000ng/l and 57,000ng/l of PFOS, respectively. And the actual fertiliser product itself tested at 13,000ng/l of PFOS in about 100g of the product. The source of the PFAS contaminating these biosolids isn't entirely clear, but it is likely to be from runoff entering drains. This wastewater could be contaminated by PFAS-containing firefighting foams, industrial effluent, landfill leachate and other unknown sources.

Earlier this year, the EPA released long-awaited regulations that set national and enforceable drinking water standards for six PFAS, known as maximum contaminant levels (MCLs), which specified 4ng/l for both PFOA and for PFOS individually, as well as 10ng/l for GenX. The agency also proposed health-based, non-enforceable MCL goals of zero for PFOA and PFOS because 'there is no dose below which either chemical is considered safe'.

Those thresholds are dramatically lower than the non-regulatory 70ng/l lifetime health advisory for drinking water that the EPA established in 2016 for PFOA and PFOS.

Biomagnifying up the food chain

Kyla Bennett, an ecologist who directs science policy for the nonprofit group Public Employees for Environmental Responsibility (Peer) and served as a consultant for the investigation, had previously been involved in a couple of cases involving biosolids and quickly connected the dots. 'When we heard "biosolids", we were like, "Well, we know what's killing all of their animals",' recalls Bennett, a former wetland permit reviewer and wetlands enforcement coordinator at the EPA.

The PFAS contained in the biosolids can seep into the soil, groundwater and surface waters of land treated with this fertiliser. This can contaminate plants grown there, which are then eaten by livestock with the contamination moving up the food chain to people.

'What we think is happening is that all this PFAS leached onto the neighbouring farm – to our clients,' Bennett tells Chemistry World. 'It got into the water – into the stock ponds – and the cows are drinking

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and swimming in those stock ponds and eating the grass, which is now contaminated with PFAS, and it biomagnifies through the food chain.'

'The PFAS accumulates in larger and larger amounts from soil to vegetation to animals,' she explains, noting that her affected clients have stopped selling their meat since they discovered the contamination.

Besides the criminal investigation that Ames is leading, there are two other related legal cases running in parallel.

Parallel lawsuits

The first involves Peer suing the EPA to force the agency to start regulating PFAS in biosolids under the Clean Water Act (CWA), which would involve prohibiting products from being applied to land if they contain PFAS in amounts above a certain threshold. The agency moved to dismiss that lawsuit back in September, arguing that the CWA only requires that it review biosolids regulations every two years but not actually identify 'additional toxic pollutants' to be regulated.

The other ongoing case is a liability lawsuit, launched by affected farmers, against Synagro and its Texas affiliate and brought by a private law firm. It seeks financial compensation for the plaintiffs – compensatory and punitive damages of more than $75,000.

'Similar instances of PFAS poisonings of farms, dairies and ranches have occurred in several states,' Bennett stated when announcing that lawsuit in February. She pointed out that Maine outlawed application of biosolids back in April 2022 after more than 60 farms were found to have unsafe levels of PFAS contamination. 'This lawsuit against Synagro will likely be the first of many,' Bennett predicted.

Michigan and Colorado have also put in place regulations requiring their wastewater treatment plants to assess and report the levels of PFAS contamination and control the entry of these chemicals into the wastewater system from major industrial sources.

States are stepping up in the absence of federal action. The EPA has no authority to regulate contaminants like PFAS in biosolids and it currently only requires that they be tested for nine heavy metals and a handful of pathogens.

EPA taking 'far too long'

There is a consensus among many stakeholders about the importance of federal regulation of PFAS in biosolids. 'If we're regulating drinking water

to 4[ng/l] then biosolids should be regulated at probably not 4[ng/l], but at some figure not much higher than that,' Woolley states.

Ames agrees. 'When the EPA says that these chemicals are so dangerous that we can't afford to have more than 4[ng/l] in drinking water … can you tell me how in the hell it would be okay to sit down and eat a calf's liver … that has 610,000[ng/l] of PFOS in it?' she asks.

Before they started being applied as fertiliser, biosolids were disposed of in lakes, streams and oceans, contaminating waterways and marine life. Then the CWA, which became law in 1972, allowed application of this organic matter to farmland.

The EPA has been investigating whether PFAS should be regulated in biosolids for several years now and the agency is taking 'far too long' to act, according to Bennett. 'We're losing farms all across the country,' she says. 'If you look at Maine, they have something like 70-plus impacted farms, and Michigan, Minnesota, New Mexico – everywhere you look – we're finding problems.'

PFAS is ubiquitous in consumer products and these chemicals are not removed during wastewater treatment. In fact, up to 19 times more PFAS are created during this process because some of these chemicals get partially broken down and then recombine and form new PFAS compounds, according to Bennett.

Currently, there are three EPA-approved methods for disposing of biosolids – incineration, landfill and applying them to land. The cheapest option is to sell such products as fertiliser to farmers for anywhere from $30–$40/tonne, Woolley notes.

Meanwhile, the EPA still has no standard definition of PFAS. Bennett argues that the agency should define these chemicals broadly, regulate them as one class, and ban all non-essential uses. 'If they do those three very simple things, then there won't be PFAS in our consumer products and it won't be in the biosolids, and then they can land apply it,' she states.

Legislating for PFAS

In terms of what's next for Johnson County, the legislative session starts in late January, and one of Woolley's goals is to educate county leaders, as well as state representatives and state senators, about the risk of PFAS-contaminated biosolids in fertiliser. He and fellow commissioners are currently working on developing draft legislation to address the issue.

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At the state level, Texas state congresswoman-elect Helen Kerwin introduced legislation on 19 December to strictly limit the amount of PFAS chemicals in fertilisers and other agricultural materials. This bill would also require manufacturers to regularly test for, and publicly report, PFAS levels.

There is concern about progress at the national level in the US. Bennett, for example, is not optimistic about the new administration, noting that Project 2025 – a conservative blueprint for a second Trump presidency that was crafted with input from several of the president-elect's former cabinet members – clearly expresses an intent to revisit PFAS regulations and the designation of these chemicals as 'hazardous substances'.

The Republican senator who will chair the Senate Environment and Public Works Committee in the new Congress, Shelley Moore Capito, recently repeated claims that the EPA's new, stricter PFAS drinking water standards are based on questionable science and she suggested that these regulations are too costly for water utilities to implement.

Water utilities and chemical companies are already challenging these rules in court, with the former arguing that they significantly underestimate nationwide compliance costs, and the latter maintaining that the regulations exceed the agency's authority.

'The EPA is being sued over the MCLs, and under a Trump EPA I can see them saying, "Yep, you're right, never mind, we'll revisit this"', Bennett states. She notes that these drinking water standards aren't even in effect because the EPA gave public water systems five years – until 2029 – to comply.

PFAS-contaminated biosolids in fertilisers is not just a Johnson County or Texas problem, Bennett emphasises. 'This is a national crisis that is threatening our entire food supply,' she warns. 'We cannot afford to have a state-by-state solution to this problem – we need a federal solution.'

Chemistry World, 12 February 2024

https://chemistryworld.com

Chemists Create Recyclable Alternative to Durable Plastics

2025-01-31

Car tires, replacement hip joints, bowling balls – these and other items are made from a class of plastics called thermosets, known for extreme durability.

Their "crosslinked polymer" chemical structure guarantees longevity but also makes these petrochemical-based materials – which comprise 15%-20% of all polymers produced – impossible to recycle.

"Currently, zero percent of the world's thermoset materials are recycled – they're either incinerated or thrown in landfills," said Brett Fors, professor of chemistry and chemical biology in the College of Arts and Sciences.

The Fors lab has addressed that environmental challenge by creating an alternative made from a bio-sourced material that has crosslinked thermosets' durability and malleability but can be easily recycled and degraded.

"The whole process, from creating to reusing, is more environmentally friendly than current materials," said Reagan Dreiling, a doctoral student in the field of chemistry and first author of "Degradable Thermosets via Orthogonal Polymerizations of a Single Monomer," which published Jan. 29 in Nature.

According to Fors, the corresponding author, it's also remarkable chemistry that initiates two polymerization processes from one monomer base.

The Fors group studies dihydrofuran (DHF), a monomer – or chemical building block – that can be made from biological materials and has the potential to eventually compete with petroleum-based feedstocks.

Dreiling used DHF, a circular monomer with a double bond, as a building block for two successive polymerizations, the second of which results in a crosslinked polymer.

The first polymerization process involves opening the circular monomer and stitching many of them together, creating a long, open chain. Flexible and soft, the resulting material can be completely chemically recycled using heat and degraded by acid, Dreiling said.

Not all DHF is consumed in the first polymerization though, and the remaining DHF is crucial for toughening the material in the subsequent polymerization, Dreiling said. In the second step, DHF monomers are connected to each other and to the first polymer while keeping their rigid, circular structures intact, yielding a material that is strong and tough. This final crosslinked polymer can be recycled through heating and will degrade naturally in the environment.

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The first polymer, the flexible one, retains a double bond that is needed to make the second, in a reaction initiated and controlled by light.

"It's so easy," Dreiling said. "Just by changing the amount of time you run each reaction for, the amount of catalyst you put in each reaction, and the intensity of light you use, you can get a wide scope of properties through a simple process."

The more light that reaches the material, Fors said, the more crosslinking and the harder the material. The parts that have received less light will stretch more; the parts of the material not hit by light are completely chemically recyclable.

DHF thermosets show comparable properties to commercial thermosets, including high-density polyurethane (used in electronics instruments, packaging and footwear, for example) and ethylene propylene rubber (used in garden hoses and automotive weatherstripping).

In contrast to current petrochemical thermosets, the DHF-based materials offer a circular economy of use, Fors said. Chemically recyclable, the material can be made back into its building block monomer and used again from scratch. And when some of the material inevitably leaks into the environment, these materials will degrade over time into benign components.

The researchers are working toward applications, including making the DHF-based material useful for 3D printing. They are also experimenting to expand the properties with additional monomers.

"We've spent 100 years trying to make polymers that last forever, and we've realized that's not actually a good thing," Fors said. "Now we're making polymers that don't last forever, that can environmentally degrade."

Technology Networks, 31 January 2025

https://technologynetworks.com

Worm surface chemistry reveals secrets to their development and survival

2025-02-12

A new study has revealed the clearest-ever picture of the surface chemistry of worm species that provides insights into how animals interact with their environment and each other. These discoveries could

pave the way for strategies to deepen our understanding of evolutionary adaptations, refine behavioral research, and ultimately overcome parasitic infections.

Scientists from the University's School of Pharmacy used an advanced mass spectrometry imaging system to examine the nematodes Caenorhabditis elegans and Pristionchus pacificus, aiming to characterize species-specific surface chemical composition and its roles in physiology and behavior.

Their results show that nematode surfaces are predominantly oily or lipid-based, forming a complex chemical landscape. The findings have been published in theJournal of the American Chemical Society.

Nematodes, or worms, are found in nearly every environment on Earth, including inside animals, soil, plants, seeds, water, and even humans. Infections caused by nematodes can lead to serious health conditions in severe cases.

This research was led by Dr. Veeren Chauhan, an Assistant Professor in Whole Organism Analytics at the School of Pharmacy. He explained, "Nematodes are an excellent model for human biology and are considered to be some of the most completely understood animals on the planet—especially in terms of genetics, neurology and developmental biology.

"We share around 60–70% of our DNA with these worms, so any new discoveries about them can significantly enhance our understanding of human biology and can contribute towards solving global human health challenges.

"Using world-leading mass spectrometry facilities, we studied the surface chemical properties of nematodes throughout their development. This allowed us to track molecular changes in detail and observe how surface chemistry differs during development, varies between species, and, importantly, influences their interactions with one another."

The team used the state-of-the-art 3D-OrbiSIMS instrument at the University of Nottingham to reveal that the surface chemistry of both worm species changes over time and they are made up of predominantly lipids, which account for approximately 70–80% of the molecular composition.

The University of Nottingham was one of the first institutions in the world to obtain a 3D-OrbiSIMS instrument. This instrument enables an unprecedented level of mass spectral molecular analysis across a range

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of materials, including hard and soft matter as well as biological cells and tissues.

When the surface sensitivity, high mass resolution and spatial resolution, are combined with a depth profiling sputtering beam, the instrument becomes an extremely powerful tool for chemical analysis as demonstrated in this recent work.

Dr. Chauhan continues, "Discovering that these worms have predominantly oily, or lipid-based, surfaces is a significant step in understanding their biology. These lipid surfaces help maintain hydration and provide a barrier against bacteria, which are essential for their survival.

"What is also very interesting is that these lipids also appear to serve as chemical cues that influence interspecies interactions, such as predation. For example, the predatory behavior of Pristionchus pacificus is guided by physical contact with the surface lipids of its prey, Caenorhabditis elegans, and alterations in these lipids can increase the susceptibility of the prey to predation."

Gaining this level of understanding of the surface chemistries of these worms and how they influence interaction and survival opens up new areas of scientific discovery and could ultimately help in developing strategies to fight parasitic worms and the diseases that they cause."

This research was conducted in collaboration with the Lightfoot Lab, led by Dr. James Lightfoot, at the Max Planck Institute for Neurobiology of Behavior—caesar in Bonn, Germany.

Phys Org, 12 February 2025

https://phys.org

Unexpected Discovery Leads to a Catalyst That Improves Over Time

2025-02-10

Scientists have developed a revolutionary catalyst that not only converts CO2 into valuable products but actually increases in activity over time.

Made from tin microparticles on a nanotextured carbon structure, this innovative electrocatalyst efficiently produces formate—a key compound for various industries. Unlike conventional catalysts that degrade, this one self-optimizes by breaking down into smaller tin nanoparticles, dramatically improving performance.

Breakthrough Catalyst for CO2 Conversion

Scientists have developed a sustainable catalyst that becomes more effective as it operates, converting carbon dioxide (CO2) into valuable products. This breakthrough provides a foundation for designing next-generation electrocatalysts.

A research team from the University of Nottingham's School of Chemistry and the University of Birmingham created the catalyst using tin microparticles supported by a nanotextured carbon structure. The interaction between the tin particles and graphitized carbon nanofibers plays a crucial role in transferring electrons from the carbon electrode to CO2 molecules—an essential step in converting CO2 into formate when an electric potential is applied.

These findings were published today (February 10) in ACS Applied Energy Materials, a journal of the American Chemical Society that focuses on interdisciplinary research in materials for energy applications.

Addressing CO2 Emissions with Electrocatalysis

CO2 is the primary contributor to global warming. While CO2 can be converted into useful products, traditional thermal methods typically rely on hydrogen sourced from fossil fuels. Therefore, it is essential to develop alternative methods like electrocatalysis, which utilizes sustainable energy sources, such as photovoltaics and wind power, as well as the abundant availability of water as a hydrogen source.

In electrocatalysis, applying an electric potential to the catalyst drives electrons through the material to react with CO2 and water, producing valuable compounds. One such product, formate, is widely used in the chemical synthesis of polymers, pharmaceuticals, adhesives, and more. For optimal efficiency, this process must operate at low potential while maintaining high current density and selectivity, ensuring effective use of electrons to convert CO2 to desired products.

Nanotextured Carbon Enhances Catalyst Performance

Dr. Madasamy Thangamuthu, a research fellow at the University of Nottingham co-led the research team, he said: "A successful electrocatalyst must strongly bond to the CO2 molecule and efficiently inject electrons to break its chemical bonds. We developed a new type of carbon electrode that incorporates graphitized nanofibers with a nanoscale texture, featuring curved surfaces and step edges, to enhance interaction with tin particles."

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Tom Burwell, a research assistant at the University of Nottingham undertook the work whilst studying at Centre for Doctorial Training in Sustainable Chemistry. He developed the approach and carried out the experimental work, he said: "We can assess the performance of the catalyst by measuring the electrical current consumed by the reacting CO2 molecules. Typically, catalysts degrade during use, resulting in decreased activity. Surprisingly, we observed the current flowing through tin on nanotextured carbon increased continuously over 48 hours. Analysis of the reaction products confirmed nearly all electrons were utilized to reduce CO2 to formate, boosting productivity by a factor of 3.6 while maintaining nearly 100% selectivity."

Tin Nanoparticles Boost Efficiency

The researchers linked this self-optimisation to the tin microparticles breaking down into nanoparticles, as small as 3 nm, during the CO2 reduction reaction. Tom Burwell elaborated: "Using electron microscopy, we found that smaller tin particles achieved better contact with the nanotextured carbon of the electrode, improving electron transport and increasing the number of active tin centers nearly tenfold."

This transformative behavior differs significantly from previous studies, where structural changes in catalysts are often seen as detrimental. Instead, the carefully engineered support in the catalyst developed by the Nottingham team allows for dynamic adaptation of tin and improved performance.

Sustainable Solutions for a Net-Zero Future

Professor Andrei Khlobystov, School of Chemistry, University of Nottingham, said: "CO2 is not only a well-known greenhouse gas but also a valuable feedstock for the production of chemicals. Consequently, designing new catalysts from earth-abundant materials like carbon and tin is vital for sustainable CO2 conversion and achieving the UK's net-zero emissions target. Our catalysts must also remain active over extended use to ensure best value."

This discovery marks a step change in understanding the design of supports for electrocatalysis. By precisely controlling the interaction between the catalysts and their supports at the nanoscale, the team has

laid the groundwork for highly selective and stable catalysts to convert CO2 into valuable products.

Sci Tech Daily, 10 February 2025

https://scitechdaily.com

Starchy nanofibers shatter the record for world's thinnest pasta

2024-12-03

The world record for the thinnest pasta has been shattered, though the new, narrow noodles are better suited to wound dressings than the dinner table.

From white flour, researchers made starch-rich nanofibers that are about 370 nanometers thick, on average — or about two hundredths the thickness of a human hair. The nano-noodles could be used in biodegradable bandages, chemist Adam Clancy and colleagues reported October 30 in Nanoscale Advances.

To make the noodle "dough," the scientists mixed the flour with formic acid, a liquid that helps uncoil the long starch molecules in the flour. "Normally, if you want to cook starch, then you use water and heat to break up the tight packing of starch," says Clancy, of University College London. "We do that chemically with formic acid. So we effectively pickle it instead of cooking it."

The researchers carefully warmed the dough to give it the right consistency. Then, via a technique called electrospinning, they used an electric charge to pull the mixture through a needle and onto a plate a few centimeters away (SN: 4/4/06). The starch molecules tangle with each other as they leave the needle, forming a continuous jet. As the jet flies through the air, the formic acid evaporates, leaving a thin fiber behind. After about 30 seconds, the fiber forms a thin mat on the plate.

Mats made from starchy nanofibers typically have pores that are large enough to let water molecules through but too small for bacteria to enter, making them attractive options for bandages and wound dressings. Previous research has made electrospun mats from pure starch, but the process of extracting that starch from plant matter is energy- and water-intensive. The new study shows that the extraction isn't strictly necessary.

"If you use it for bandages, it doesn't really matter that there's cellulose and protein there," Clancy says.

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Since the fibers are made of dried flour, they can be classified as pasta. That makes them the thinnest pasta on record — roughly a thousandth the width of su filindeu, a type of pasta about half the width of angel hair noodles that's exclusively handmade by just one family in the town of Nuoro, Italy.

But is Clancy's nanopasta edible? "I certainly hope so," he says.

Science News, 3 December 2024

https://sciencenews.org

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