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

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ASIA PACIFIC

Chemical added to the Inventory following the issue of an assessment certificate

2023-04-14

AICIS Approved Chemical Name (AACN)	Fatty acids, dimers, hydrogenated, polymers with alkanediol and methylenebis[isocyanatobenzene]
Defined scope of assessment	The polymer was assessed for industrial adhesive and sealant use (non-spray): imported into Australia at up to 35 tonnes per year imported at a concentration of 20% or less, in finished end-use products as having low molecular weight species less than 1000 g/mol below 7% and less than 500 g/mol below 1%
Specific Information Requirements	Introducers of the assessed chemical, including assessment certificate holders or persons covered by an assessment certificate, must advise the Executive Director within 20 working days if additional information has become available to the person as to reports of an adverse effect of the assessed chemical on worker health and safety.
Listing date	6 April 2023

AICIS Approved Chemical Name (AACN)	2-Propenoic acid, branched alkyl ester, polymer with 1-alkene
Defined scope of assessment	This chemical has been assessed as: as a polymer that meets the PLC definition (Schedule 2 of the Rules) and as a polymer that is not a high molecular weight polymer that has lung overloading potential (within the meaning given by the Industrial Chemicals Categorisation Guidelines) as an ingredient in lubricant products for general machinery
Listing date	6 April 2023

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CAS number	2252265-89-5
Chemical name	Alkanes, C8-18-branched and linear
Molecular formula	Unspecified
Defined scope of assessment	The chemical has been assessed for use as an aviation (jet) fuel that is imported into Australia in a neat form. The importation volume is up to 80,000 tonnes per year.
Listing date	6 April 2023

Published date 14 April 2023

Read More

AICIS, 14-04-23

<https://www.industrialchemicals.gov.au/news-and-notice/chemical-added-inventory-following-issue-assessment-certificate-early-listing-14-april-2023>

Steviol Glycosides Risk Assessment Report

2023-04-15

Food Standards Australia New Zealand (FSANZ) has just released the report from a recent risk assessment of steviol glycosides.

The risk assessment was part of a joint New Zealand Ministry for Primary Industries (MPI) and FSANZ project to review intense sweeteners permitted in the Food Standards Code.

As part of the assessment, an analytical survey was conducted to determine the concentrations at which steviol glycosides are present in a variety of foods in Australia and New Zealand and undertake a refined dietary exposure assessment.

The survey found that the estimated dietary exposures to steviol glycosides were well below the Acceptable Daily Intake (ADI) for the Australian and New Zealand populations assessed. Based on the current evidence available, no public health and safety issues were identified from the risk assessment.

To read the full report about steviol glycosides, visit our website.

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[Read More](#)

Food Standards Australia New Zealand News, 15-04-23

<https://mailchi.mp/c33de17b2b1d/food-standard-news-1300712?e=%5bUNIQID%5d>

Codex Committee on Food Additives

2023-04-15

FSANZ continues to support collaborative efforts to harmonise international food standards.

International, Recalls, Incidents and Strategic Science Section Manager Steve Crossley recently attended the 53rd session of the Codex Committee on Food Additives in Hong Kong.

FSANZ has been leading the Committee's work on aligning international food standards for the past decade, including writing the proposed amendments to the General Standard on Food Additives and the associated Commodity Standards.

[Read More](#)

Food Standards Australia New Zealand News, 15-04-23

<https://mailchi.mp/c33de17b2b1d/food-standard-news-1300712?e=%5bUNIQID%5d#mctoc1>

Public consultations

2023-04-15

Application A1245 – Alpha-glucosidase from GM *Trichoderma reesei* as a processing aid in brewing

FSANZ invites written submissions on the assessment of the additional use of alpha-glucosidase from *Trichoderma reesei* containing the alpha-glucosidase gene from *Aspergillus niger* as a processing aid in brewing of beer. Submissions close 6pm (Canberra time) 25 April 2023.

Application A1262 – Food derived from insect-protected corn line MON95275

FSANZ invites written submissions on the assessment of food derived from corn line MON95275, genetically modified for protection from coleopteran insect pests. Submissions close 6pm (Canberra time) 18 May 2023.

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For more information and to have your say, see our website.

[Read More](#)

Food Standards Australia New Zealand News, 15-04-23

<https://mailchi.mp/c33de17b2b1d/food-standard-news-1300712?e=%5bUNIQID%5d#mctoc1>

AMERICA

The Longstanding Hazards of U.S. Pesticide Exportation Exposed (Again) by Petition to EPA

2023-04-04

A petition to the U.S. Environmental Protection Agency (EPA) implores the agency to halt the practice of allowing pesticides banned in the U.S. to be exported to other countries without any consent from relevant governmental authorities in those nations. The two petitioners—the Center for Biological Diversity (CBD) and the Center for International Environmental Law (CIEL)—are focusing on a longstanding practice of U.S. pesticide manufacturers and brokers, who sell toxic pesticide products that fail to qualify for EPA registration domestically to entities nearly anywhere in the world (except where the products are specifically prohibited). As Beyond Pesticides has noted, this is a dangerous and environmentally unjust practice and has for decades urged Congress and EPA to forbid it.

According to the CIEL press release on the matter, the petition was motivated by the reality that banned or voluntarily withdrawn pesticides “are routinely exported to countries that often have limited resources or capacity to assess and regulate chemical risks,” and that the “practice has directly fueled the influx of extremely hazardous pesticides to countries in the Global South, where they disproportionately harm Indigenous peoples and vulnerable and marginalized communities.” The organizations emphasize that, for example, more than four-fifths of countries that import neurotoxic pesticide compounds that are banned in the U.S. are regarded as developing or low-to-middle income, and that in more than three-fourths of those, roughly 30% (or more) of their agricultural workers suffer pesticide poisoning annually.

The petitioners argue that what they are urging EPA to do — “initiate rulemaking procedures to require prior informed consent for the export

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of pesticides unregistered in the United States” — would help less-well-resourced nations make informed decisions about whether (or under what conditions) to allow such hazardous products into their countries.

The petition notes, “Current EPA regulations and practice on the export of unregistered pesticides are incompatible with the legislative text and purpose of the FIFRA provisions. This becomes even more apparent in light of accepted understandings of ‘notice’ that have developed since 1978, and the fundamental change in pesticide trade since that time. The regulatory, scientific, and public health context with respect to pesticides and hazardous substances has shifted profoundly in the 65 years since FIFRA’s original adoption, and in the more than four decades since the statutory language of FIFRA §17 was amended to its current form.” (FIFRA is the Federal Insecticide, Fungicide, and Rodenticide Act, the statute that governs the registration, regulation, sale, and use of pesticides.)

The petition also calls out the environmental injustice of current practice, and endorses the 2019 conclusions of United Nations Special Rapporteur on Toxics Baskut Tuncak, JD. He then said that all countries — in order to “meet their obligations to respect, protect, and promote fundamental human rights,” must “adopt laws and policies consistent with their duty under international human rights law to prevent exposure to hazardous substances, protect the most vulnerable and susceptible and prevent discrimination; prohibit the export of chemicals and production processes that are prohibited from use domestically; and prevent the import of chemicals and production processes that are prohibited in the country from which they are exported.”

The petition cites three central arguments underlying its request for new rulemaking:

- The U.S. has binding obligations to provide prior informed consent regarding exports of delisted or unregistered pesticides under treaties which it has signed or ratified.
- The U.S. has a duty to ensure prior informed consent as a matter of customary international law.
- Prior informed consent is a legal tradition rooted in U.S. domestic law.

Absent prior informed consent (PIC), these unregistered pesticides are able to cross national borders and are often deployed “on the ground” with minimal oversight or enforcement of regulations that may exist. CBD and CIEL further argue that PIC is a “widely accepted legal concept that has been defined by many U.S. statutes, including FIFRA, U.S. multi-lateral agreements, and other international treaties and agreements.”

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Read More

Beyond Pesticides, 04-04-23

<https://beyondpesticides.org/dailynewsblog/2023/04/the-longstanding-hazards-of-u-s-pesticide-exportation-exposed-again-by-petition-to-epa/>

EPA’s Proposed Rules Would Severely Limit PFAS Levels Permissible in Drinking Water

2023-04-17

Last month, the U.S. Environmental Protection Agency (EPA) published new proposed rules under the Safe Drinking Water Act that will severely limit the levels of certain substances of a man-made family of chemicals, collectively known as “PFAS,” permissible in drinking water. PFAS National Primary Drinking Water Regulation Rulemaking, 88 FR 18638 (March 29, 2023).

PFAS (per- and polyfluoroalkyl substances) are a group of synthetic chemicals that have been linked to serious conditions such as cancer, thyroid disease, fertility issues, and liver damage. They are commonly known as “forever chemicals” because their chemical and physical properties allow them to accumulate over time and make them resistant to degradation. They break down very slowly in the environment and in the bodies of humans and animals. PFAS have been used since the 1940s and are commonly found in consumer and industrial products, such as clothing, cookware, cosmetics, food packaging, carpeting, and fire-fighting foam. Aside from direct exposure to PFAS via a consumer or industrial product, humans may be exposed to PFAS in drinking water. The high prevalence of PFAS in the environment has led them to be found in the blood of 98% of people in the U.S., according to the CDC.

The EPA’s proposed rule would limit the levels of certain PFAS in drinking water, setting the maximum contaminate level (MCL) at four parts per trillion (ppt) for two types of PFAS—PFOA and PFOS (perfluorooctanoic acid and perfluorooctane sulfonic acid, respectively). This equates to a mere 4 drops of water in an Olympic sized pool. In addition to setting the MCLs, the EPA has also proposed maximum contaminant level goals (MCLGs), which unlike MCLs, are aspirational and are not enforceable limits. MCLGs are based solely on the levels that are safe for the public’s health, representing the level at which no known or anticipated adverse effects on the health of persons is expected to occur and allows an adequate margin of safety, without consideration for the feasibility and

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technological limitations of testing and treatment. For PFOA and PFOS, the EPA has stated that the MCLG should be zero parts per trillion, i.e., there is no safe level for humans.

Several states have already implemented limits on the amount of certain PFAS in drinking water; however, most states have not yet enacted any binding regulations. Regardless, the new EPA limits are more stringent than any current state limits. Therefore, all states will be required to take action to come into compliance with the EPA's proposed regulations once finalized.

Read More

JD Supra, 17-04-23

<https://www.jdsupra.com/legalnews/epa-s-proposed-rules-would-severely-1823963/>

Maine's PFAS Regulations—Important Dates Are Coming

2023-04-18

In July 2021 the Maine Legislature enacted HP 1113 or LD 1503, "An Act To Stop Perfluoroalkyl and Polyfluoroalkyl Substances Pollution," which took effect January 1, 2023. This legislation is the first of its kind in the United States related to the direct usage of per- and polyfluoroalkyl substances (PFAS) in new products. The statute is two-tiered. The first tier is an outright prohibition, effective January 2023, on the sale or distribution of carpets, rugs, and fabric treatments with intentionally added PFAS. The second tier requires all other products that contain intentionally added PFAS to register with Maine's Department of Environmental Protection (MDEP). MDEP may identify registered products, by category or use, that may not be sold or distributed in the state. Entities must notify persons who sell or distribute that product that the sale of that product is prohibited in Maine, as well as provide MDEP a list of those notified. MDEP's discretion on product prohibition will be based on its judgment of which products are most likely to contaminate the state's land or water. Effective January 1, 2030, all products with intentionally added PFAS will be prohibited from sale or distribution in the state, unless MDEP exempts the product because the usage is specifically designated and approved. The law also requires entities to provide MDEP with a certificate of compliance attesting that the product does not contain intentionally

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added PFAS if the product is not registered with the state and MDEP has a reason to believe that the product contains intentionally added PFAS.

While the goals of the legislation are laid out in the law, the rules to implement the components of the law are still under development by MDEP. Key elements of the draft rules include:

- A manufacturer of a product for sale in the state and containing intentionally added PFAS with an associated CAS Registry Number shall submit to the State of Maine written notification about the purpose of using PFAS in their product, amount used, and other manufacturing information.
- Manufacturers must provide written notification of any significant change in such information or upon request by the State.
- Products that contain PFAS that must comply with federal government regulations may be exempt from state rules.
- Except for resale, no one may sell, offer for sale, or distribute for sale carpets, rugs, or fabric treatments that contain intentionally added PFAS.
- Maine's law will ban use of all PFAS in products, except for essential uses, by 2030.

Read More

JD Supra, 18-04-23

<https://www.jdsupra.com/legalnews/maine-s-pfas-regulations-important-3686658/>

EPA agrees to regulate oil and gas sources' hazardous air pollution emissions

2023-04-18

Millions of people in the U.S. live within a mile of oil and gas sources that emit tons of unregulated hazardous air pollutants

The Environmental Protection Agency has agreed to review its regulations on dangerous air pollution from oil and gas equipment. On Monday, a federal court signed a consent decree between EPA and environmental advocates who sued the agency for its failure to review its decade-old air toxic standards for this sector.

The law currently allows companies to expose millions of people in the U.S. to massive amounts of harmful pollution from unregulated sources

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in the oil and gas industry. EPA last reviewed toxic air standards for oil and gas sources in 2012. Community and environmental advocates challenged that rule, arguing that it allows most components of oil and gas facilities, such as wells, impoundments, and waste storage pits, to spew air pollutants of any type without limit. Advocates petitioned EPA to reconsider its rule and eliminate an illegal loophole that allows industry to avoid liability for excess emissions during malfunctions before suing the agency last year for failing to respond to their request for nearly a decade.

These facilities operate in neighborhoods across the U.S., and a vast swath of them either lack sufficient limits on the full range of hazardous air emissions or lack any such limits altogether.

“EPA must use this rulemaking as an opportunity to remedy the longstanding under-regulation of this massive group of industrial facilities, pollution from which daily threatens the health of people living, working, and attending school nearby,” said Earthjustice attorney Adrienne Lee.

EPA should promptly act to protect communities living near oil and gas developments. Under the consent decree, the agency agreed to meet three court-enforced deadlines. First, by February 2024, EPA will issue a proposed rule on the illegal emissions loophole. By December 2024, EPA will take final action on this loophole and sign a proposed rule on its review of the oil and gas air toxics standards, including all necessary revisions. By December 2025, EPA will finalize any revisions to the oil and gas air toxics standards.

Read More

Earth Justice, 18-04-23

<https://earthjustice.org/press/2023/epa-agrees-to-regulate-oil-and-gas-sources-hazardous-air-pollution-emissions>

Court throws out Berkeley, California’s ban on natural gas

2023-04-18

A federal appeals court on Monday overturned Berkeley, California’s first-in-the-nation ban on natural gas in new construction, agreeing with restaurant owners who argued the city bypassed federal energy regulations when it approved the ordinance.

The measure, which took effect in 2020 to cheers from environmentalists, was intended to reduce emissions of greenhouse gasses that contribute

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to global warming. With some exceptions, it banned new residential and commercial buildings from installing natural gas piping in favor of electrical lines.

A lawsuit by the California Restaurant Association claimed the regulation violated federal law that gives the U.S. government authority to set energy-efficiency standards for appliances such as stoves, furnaces and water heaters.

The Ninth U.S. Circuit Court of Appeals in San Francisco rejected a lower court judge’s decision two years ago that had upheld the Berkeley ordinance. In her 2021 decision, U.S. District Judge Yvonne Gonzalez Rogers said the city was not trying to regulate energy efficiency for appliances, only the fuel they used.

Read More

AP News, 18-04-23

<https://apnews.com/article/berkeley-california-natural-gas-ban-overturned-appeals-court-7dafca58d19963f322100d73caf9c31a>

Moving Canada to its Zero Plastic Waste Goal

2023-04-18

Backgrounder

In support of the Canada-wide Strategy on Zero Plastic Waste adopted by the Canadian Council of Ministers of the Environment, the Government of Canada is launching two consultations on: 1) a regulatory framework which serves as a starting point for the proposed Recycled Content and Labelling for Plastic Products Regulations, and 2) a technical paper that outlines reporting requirements for the federal plastics registry.

The consultations will be open until May 18, 2023.

Recycled content and rules for recyclability and compostability labelling

In Canada, plastic packaging represents nearly half of all the plastic that ends up in landfills. Currently, less than 15 percent of plastic packaging waste is recycled. Labels on plastic packaging that claim recyclability or compostability are often inaccurate, and Canadians are not given clear information about whether an item should be put in a recycling bin, a composting bin, or the garbage. This can result in confusion and products ending up in the wrong place.

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In addition, most plastic products on the market today are made from non-renewable fossil fuels. The success of recycling relies on the use of recycled plastics in the manufacture of new products. However, there are several interrelated factors impeding recycled plastic use, including weak markets for recycled plastics, the lower cost of primary resins, insufficient recycling and infrastructure systems, and products not being designed for recycling.

Since 2022, the Government has conducted consultations on rules for recycled content and recyclability labelling. The results of the consultations on labelling are summarized in the What We Heard Report. Feedback received to date has informed the regulatory approach outlined in the regulatory framework paper published on April 18, 2023, which is subject to a 30-day comment period. Consultations will engage key stakeholders and solicit feedback to better inform the development of the proposed Regulations, which will be published before the end of 2023.

Federal plastics registry for producers of plastic products

The Government of Canada supports provincial and territorial efforts to improve recycling systems through Extended Producer Responsibility (EPR). Through EPR, a producer is made responsible for the collection and management of products and packaging at the end of their life.

Currently, reporting requirements for EPR programs are inconsistent across Canada, using different definitions, calculations, and measurements of success. This makes it hard for Canadians to access information or to know how EPR is helping Canada move toward its goal of zero plastic waste. A federal plastics registry would harmonize data, make it openly accessible in one place, and support provinces and territories in making producers responsible for the waste created by the products they sell, thereby improving end-of-life management of these products and minimizing the potential for them to enter the environment as plastic pollution.

The Government of Canada is considering requiring producers to report data on all major categories of plastic products, covering the majority of all plastics placed on the Canadian market. These categories include packaging, construction, automotive, white goods (e.g. home appliances), electronic and electrical equipment, textiles, and agriculture.

The Government recently published the results of a public consultation on the development of a proposed federal plastics registry for producers of plastic products in the What We Heard Report.

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Progress to date

On June 20, 2022, Environment and Climate Change Canada and Health Canada published final regulations to prohibit single-use plastics, including checkout bags, cutlery, food-service ware made from or containing plastics that are hard to recycle, ring carriers, stir sticks, and straws (with some exceptions).

According to a survey released by Statistics Canada on July 19, 2022, Canadians are making progress on moving away from single-use plastics by using fewer disposable straws and relying on reusable bags, water bottles, and mugs. Ninety-seven percent of surveyed households reported using their own bags or containers when grocery shopping. More than half (51 percent) said they did this all the time. Canadians are also choosing reusable water bottles more often, with nine in ten households reporting their use in 2021.

Other key elements of Canada's approach toward reducing plastic pollution include establishing performance standards to increase the use of recycled content in certain plastic products and ensuring that manufacturers, importers, and sellers of plastic products and packaging are responsible for collecting and recycling them. The Government of Canada will continue to work collaboratively with its partners to advance its zero plastic waste agenda at home and abroad, including by working with provinces and territories through the Canadian Council of Ministers of the Environment to implement the Canada-wide Strategy on Zero Plastic Waste, and Phase 1 and Phase 2 of the associated Action Plan on Zero Plastic Waste.

Read More

Government of Canada, 18-04-23

<https://www.canada.ca/en/environment-climate-change/news/2023/04/moving-canada-to-its-zero-plastic-waste-goal.html>

California Assembly toxics panel advances landmark ban on chemicals in processed food

2023-04-20

The California Assembly's Committee on Environmental Safety and Toxic Materials Tuesday approved a first-in-the-nation bill to ban five harmful chemicals from candy, cereals, and other processed food. That approval

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followed the Assembly's Health Committee's "do pass" recommendation earlier this month.

The bill, AB 418, sponsored by Assemblymember Jesse Gabriel, would end the use of brominated vegetable oil, potassium bromate, propylparaben, Red Dye No. 3 and titanium dioxide in popular food products sold in the state. Any food manufactured elsewhere but placed for sale in California will have to comply with the regulation.

The chemicals have been linked to serious health problems, such as a higher risk of cancer, nervous system damage, and hyperactivity.

European regulators have already banned all five substances from use in food, with the narrow exception of Red No. 3 in candied cherries. Given the size of California's economy, A.B. 418 would set an important precedent for improving the safety of many processed foods.

Following Europe's lead and protecting U.S. consumers is seen by supporters as the right step, while opponents of the bill that claim it would end the sale of some candy and other popular items in the state.

"There is no realistic chance that this bill will result in Skittles or any other product being pulled off the shelf," said Gabriel, who chairs the Assembly Committee on Privacy and Consumer Protection. "The idea here is for these companies to make minor modifications to their recipes so that these products no longer include dangerous and toxic chemicals."

"Skittles and many other brands have already made changes to their recipes in the European Union, the United Kingdom, and other nations where these chemicals are banned," he continued. "While the chemical companies might want you to believe we're going too far with this bill, we are in fact many steps behind the rest of the world. We simply want our kids to have the same protection."

The Environmental Working Group and Consumer Reports support A.B. 418. The California Assembly's Appropriations Committee will next consider the bill.

EWG and CR say there are more than 10,000 chemicals allowed for use in food sold in the U.S. Nearly 99 percent of those introduced since 2000 were approved by the food and chemical industry, not the Food and Drug Administration, the agency tasked with ensuring our food supply is safe.

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"Despite the serious and well-documented risks posed to our health by these five food chemicals, the FDA has failed to take action to protect the public," said Brian Ronholm, director of food policy at Consumer Reports.

"At a time when the FDA's weak oversight has prevented it from taking action, it is critical for states like California to ensure consumers are protected from these toxic food chemicals," Ronholm continued. "By removing these harmful chemicals from candies, cookies, and other processed food, this bill will protect Californians and encourage manufacturers to make their products safer for the rest of the country."

Read More

Food Safety News, 20-04-23

<https://www.foodsafetynews.com/2023/04/california-assembly-toxics-panel-advances-landmark-ban-on-chemicals-in-processed-food/>

INTERNATIONAL

France's Drinking Water Contaminated with Toxic Fungicide Chlorothalonil, Banned in EU but Widely Used in U.S.

2023-04-18

Health officials in France are alerting the public that a majority of drinking water samples tested by the government contain the presence of the highly toxic fungicide chlorothalonil. The findings highlight a stark divide between regulations and public health management in the European Union and United States. While EU member states have banned this chemical and are working to understand and address lingering effects, tens of millions of pounds of chlorothalonil continue to be sprayed throughout the U.S. annually.

French officials say they conducted this research after researchers in Switzerland found evidence of the fungicide in drinking water. A few years ago, Swiss scientists released a report showing Evian bottled water, touted for its claims of purity, was found to contain measurable levels of chlorothalonil. "The fact that even the Evian springs in the French Alps, which are hardly affected by humans, contain pesticide residues is alarming and shows the far too careless handling of these substances," Roman Wiget, president of the international drinking water association AWBR told the German-language Swiss weekly at the time.

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The EU banned uses of chlorothalonil in 2019, due to concerns over water contamination, the effects of such contamination on fish and amphibians, and an elevated cancer risk. EU officials designated chlorothalonil as a 1B carcinogen, meaning it “may cause cancer,” with the most significant risk found for kidney cancer based on laboratory animal studies. Enough data was presented to conclude that the breakdown metabolites of the chemical have genotoxic potential, able to damage DNA and result in the development of cancer. EPA has classified chlorothalonil as a likely human carcinogen.

The fungicide presents an acute risk to amphibians, and chronic risks to fish living in contaminated water. In addition to these aquatic impacts, other research finds the chemical can harm pollinators by altering honey bee microbiomes, reducing bumblebee colony size, contributing to ongoing pollinator declines.

Chlorothalonil was found in over half of drinking water samples tested, and at amounts higher than allowable levels in one out of three tests.

“These results show that, depending on their properties, some pesticide metabolites can remain present in the environment for several years after the ban on the active substance from which they were derived,” a report on the contamination by French health officials concluded.

A rapid transition away from hazardous, industrial pesticides like chlorothalonil is urgently needed to address ongoing health, biodiversity, and climate crises. While the EU is trending in the right direction and seeking to phase out 50% of all pesticide use by 2035 as part of its Farm to Fork Strategy, a recent citizen petition recommending larger restrictions was recently rejected.

Read More

Beyond Pesticides, 18-04-23

<https://beyondpesticides.org/dailynewsblog/2023/04/frances-drinking-water-contaminated-with-toxic-fungicide-chlorothalonil-banned-in-eu-but-widely-used-in-u-s/>

What You Need to Know About ‘Forever Chemical’ Regulation in US & Europe

2023-04-19

PFAS regulations remain in limbo, but market forces are pushing ahead

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So-called “forever chemicals” have been linked to serious health problems, and regulators in both the U.S. and Europe are poised to issue rules that would eliminate these chemicals from the supply chain. Assent’s sustainability director, Cally Edgren, explores the driving forces behind possible regulation.

Per- and polyfluoroalkyl substances (PFAS) have become a hot subject for regulators. This family of durable, synthetic fluorocarbons is persistent, bioaccumulative and toxic and may be linked to health issues such as:

- Increased risk of thyroid disease and blood cholesterol levels
- Decreased fertility in women
- Lower infant birth weight

Lawmakers in many jurisdictions are taking steps to eliminate PFAS from the supply chain. Here’s a comparison of PFAS regulations in the EU and the U.S.

The EU regulatory landscape

The cornerstone chemicals compliance regulation in the EU, REACH, is poised to restrict the use of more than 10,000 PFAS chemicals.

In February 2023, the European Chemicals Agency (ECHA) published a proposal to create a strict definition of PFAS and amend the REACH list to include nearly all PFAS. These restrictions aim to make manufacturing processes and products safer for people and to avoid future environmental contamination.

EU officials have called this regulation “landmark” — not just because of the vast number of in-scope substances but because of the market impact. It will affect both manufacturers located in the EU as well as any companies selling products into the EU. With 440 million consumers, the EU isn’t a market to ignore.

Authorities in Denmark, Germany, the Netherlands, Norway and Sweden formulated the ECHA proposal, suggesting two options to restrict usage.

Read More

Corporate Compliance Insights, 19-04-23

<https://www.corporatecomplianceinsights.com/pfas-us-global-regulations/>

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REACH Update

APR. 28, 2023

ECHA recommends eight substances for REACH authorisation

2023-04-12

To protect workers and the environment, ECHA recommends that the European Commission adds eight substances, including lead, to the REACH Authorisation List. Once substances are added to the list, companies will need to apply for authorisation to continue using them.

Helsinki, 12 April 2023 – ECHA's 11th recommendation includes the following substances:

- Ethylenediamine;
- 2-(4-tertbutylbenzyl)propionaldehyde and its individual stereoisomers;
- Lead;
- Glutaral;
- 2-methyl-1-(4-methylthiophenyl)-2-morpholinopropan-1-one;
- 2-benzyl-2-dimethylamino-4'-morpholinobutyrophenone;
- Diisohexyl phthalate; and
- Orthoboric acid, sodium salt.

ECHA has prioritised these substances from the Candidate List of substances of very high concern for this recommendation as they are of the highest priority, following the agreed approach of 2014.

The inclusion of lead in the draft recommendation published on 2 February 2022 generated many comments during the consultation. It led to an active discussion in ECHA's Member State Committee related to the best timing, its combination with other ongoing or planned regulatory activities as well as the expected workload for industry and authorities at the next stage.

Ofelia Bercaru, the Director for Prioritisation and Integration, said: "This recommendation brings lead metal to the same regulatory stage as other lead compounds with similar uses already recommended for inclusion to the Authorisation List. We are aware of the challenges and considered that balancing the risks posed by lead to workers and the environment with its continued use requires a policy decision by the Commission and EU Member States."

More information about the reasons for recommending these substances for authorisation and of their uses is available in the annex and in ECHA's recommendations.

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REACH Update

APR. 28, 2023

Background

ECHA has the legal obligation to regularly recommend substances from the Candidate List for the Commission to include in the Authorisation List. Before sending its recommendation to the European Commission, comments received during a three-month consultation and the opinion of the Member State Committee are taken into account.

The European Commission will decide which substances are included in the Authorisation List and what conditions apply for each substance. If a substance is included in the Authorisation List, it can only be placed on the EEA market or used after a given date, if an authorisation is granted for a specific use.

The authorisation process aims at enhancing substitution of substances of very high concern when technically and economically viable alternatives are available. Until this is achieved, the goal is to ensure proper control of risks for human health and the environment.

Read More

ECHA, 12-04-23

<https://echa.europa.eu/-/echa-recommends-eight-substances-for-reach-authorisation>

ECHA provides advice on new hazard classes for substances and mixtures

2023-04-20

Three new hazard classes for classifying, labelling and packaging (CLP) substances and mixtures enter into force on 20 April 2023. ECHA has published information on the application dates and related guidance.

Helsinki, 20 April 2023 – The European Commission has updated the Classification, Labelling and Packaging Regulation with the following hazard classes:

- endocrine disruptors (ED) for human health or the environment;
- persistent, bioaccumulative and toxic (PBT); very persistent and very bioaccumulative (vPvB); and
- persistent, mobile and toxic (PMT); very persistent and very mobile (vPvM).

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Companies and Member State authorities can use current guidance on identifying endocrine disruptors and on PBT (persistence, bioaccumulation, toxicity) assessment until the guidance on applying the CLP criteria has been updated. It is expected to be ready in 2024.

The new hazard classes will be included in the IT tool IUCLID during spring 2024. From then on, companies will be able to include information related to the new hazard classes in their classification and labelling notifications, REACH registrations and dossiers for product and process orientated research and development (PPORD), as well as in their submissions under the Biocidal Products Regulation and poison centre notifications.

After the transition periods, it will be mandatory for companies to indicate if the substance is classified in any of the new hazard classes.

Information on transitional periods and dates when the regulation starts to apply to different substances and mixtures is available on ECHA's website.

[Read More](#)

ECHA, 20-04-23

<https://echa.europa.eu/-/echa-provides-advice-on-new-hazard-classes-for-substances-and-mixtures>

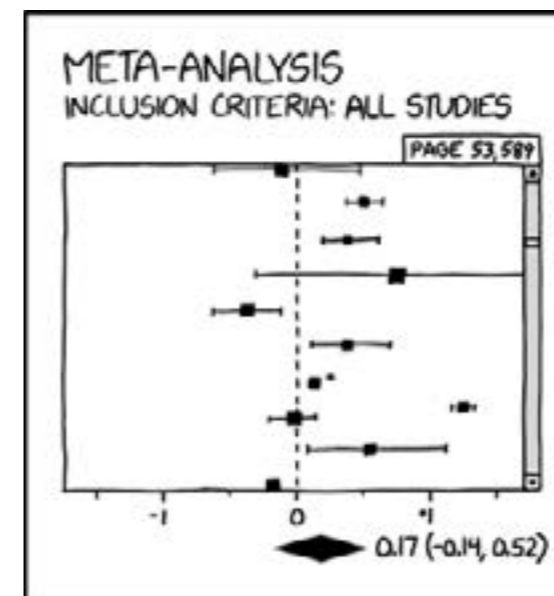
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Janet's Corner

APR. 28, 2023

Effect Size

2023-04-28



BAD NEWS: THEY FINALLY DID A META-ANALYSIS OF ALL OF SCIENCE, AND IT TURNS OUT IT'S NOT SIGNIFICANT.

<https://xkcd.com/2755/>

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Hazard Alert

APR. 28, 2023

1,1,1-trichloroethane

2023-04-28

The organic compound 1,1,1-trichloroethane, also known as methyl chloroform, is a chloroalkane with the chemical formula $C_2H_3Cl_3$ or CH_3CCl_3 . This colourless, sweet-smelling liquid was once produced industrially in large quantities for use as a solvent. It is regulated by the Montreal Protocol as an ozone-depleting substance and its use is being rapidly phased out. [1]

USES [2]

1,1,1-Trichloroethane had many industrial and household uses, including use as a solvent to dissolve other substances, such as glues and paints; to remove oil or grease from manufactured metal parts; and as an ingredient of household products such as spot cleaners, glues, and aerosol sprays. [2]

ENVIRONMENT EFFECTS [2]

- Most of the 1,1,1-trichloroethane released into the environment enters the air, where it lasts for about 6 years.
- Once in the air, it can travel to the ozone layer where sunlight can break it down into chemicals that may reduce the ozone layer.
- Contaminated water from landfills and hazardous waste sites can contaminate surrounding soil and nearby surface water or groundwater.
- From lakes and rivers, most of the 1,1,1-trichloroethane evaporates quickly into the air.
- Water can carry 1,1,1-trichloroethane through the soil and into the groundwater where it can evaporate and pass through the soil as a gas, then be released to the air.
- Organisms living in soil or water may also break down 1,1,1-trichloroethane.
- It will not build up in plants or animals.

SOURCES & ROUTES OF EXPOSURE [3]

Sources of Exposure [2]

General Population

The organic compound 1,1,1-trichloroethane, also known as methyl chloroform, is a chloroalkane with the chemical formula $C_2H_3Cl_3$ or CH_3CCl_3 .

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Hazard Alert

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- Exposure occurs principally by inhalation of low levels in air or ingestion of very low levels in water. These levels may be higher for people living near hazardous waste sites.
- Very small amounts of 1,1,1-trichloroethane have been found in some food items.
- People who still have at home consumer products such as glues, cleaners, and aerosol sprays that have 1,1,1-trichloroethane may be exposed to it by breathing vapours or by skin contact with the liquid.
- Intentional exposure can occur via sniffing household chemicals in an attempt to get "high".

Occupational Populations

- Exposure can occur during the manufacture of 1,1,1-trichloroethane for export or as a chemical intermediate in the manufacture of hydrofluorocarbons.

Routes of Exposure [3]

- Inhalation – Primary route of exposure for the general population, people near waste sites, and workers involved in the manufacture or use of 1,1,1-trichloroethane.
- Oral – Route of exposure at or near waste sites via ingestion of contaminated media. Certain foods also contain small amounts of 1,1,1-trichloroethane.
- Dermal – Route of exposure for workers involved in the manufacture and use of 1,1,1-trichloroethane and for people near waste sites via skin contact with contaminated media.

HEALTH EFFECTS [4]

Acute Effects

- Effects reported in humans due to acute inhalation exposure to 1,1,1-trichloroethane include hypotension, mild hepatic effects, and CNS depression. Mild motor impairment (e.g., increased reaction time), lightheadedness, impaired balance, and ataxia have been reported in acutely exposed humans. Cardiac arrhythmia and respiratory arrest may result from the depression of the CNS. Symptoms of acute inhalation exposure include dizziness, nausea, vomiting, diarrhoea, loss of consciousness, and decreased blood pressure.
- 1,1,1-trichloroethane is mildly irritating when applied to the skin of humans.

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- Neurological and liver effects have been observed in animals acutely exposed to 1,1,1-trichloroethane via inhalation.
- Tests involving acute exposure of animals in rats, mice, rabbits, and guinea pigs have demonstrated 1,1,1-trichloroethane to have low acute toxicity from inhalation or oral exposure and low to moderate acute toxicity from dermal exposure.

Chronic Effects

- Most studies have not reported adverse effects from chronic exposure to low levels of 1,1,1-trichloroethane in humans or animals.
- Some liver damage and neurological effects have been observed in rodents chronically exposed to 1,1,1-trichloroethane by inhalation.
- EPA has not established a Reference Concentration (RfC) or a Reference Dose (RfD) for 1,1,1-trichloroethane.
- The California Environmental Protection Agency (CalEPA) has established a chronic reference exposure level of 1 milligram per cubic metre (mg/m³) based on CNS effects in gerbils.

Reproductive/Developmental Effects

- Epidemiologic studies have found no relationship between adverse pregnancy outcomes and exposure of mothers or fathers to 1,1,1-trichloroethane.
- Animal studies have not reported developmental or reproductive effects from exposure to 1,1,1-trichloroethane.

Cancer Risk

- Information is not available on the carcinogenic effects of 1,1,1-trichloroethane in humans.
- Two animal studies have not demonstrated carcinogenicity from oral or inhalation exposure to 1,1,1-trichloroethane; however, the data are considered to be inadequate due to the low survival of the rats in one study and the low dose levels used in the second study.
- EPA has classified 1,1,1-trichloroethane as a Group D, not classifiable as to human carcinogenicity, based on no reported human data and inadequate animal data.

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SAFETY [5]

First Aid Measures

- 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 medical attention.
- Inhalation: Allow the victim to rest in a well ventilated area. Seek immediate medical attention.
- Serious Inhalation: Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.
- Ingestion: Do not induce vomiting. 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.

Exposure Controls & Personal Protection

Engineering Controls

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

Personal Protective Equipment

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

- Splash goggles;
- Lab coat;

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- Vapour respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves.

Personal Protection in Case of a Large Spill:

- Splash goggles;
- Full-suit;
- Vapour 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.

REGULATION

United States [6]

OSHA: The Occupational Safety & Health Administration has set the following Permissible Exposure Limit (PEL) for 1,1,1-trichloroethane:

- General Industry: 29 CFR 1910.1000 Z-1 Table -- 350 ppm, 1900 mg/m³ TWA
- Construction Industry: 29 CFR 1926.55 Appendix A -- 350 ppm, 1900 mg/m³ TWA
- Maritime: 29 CFR 1915.1000 Table Z-Shipyards -- 350 ppm, 1900 mg/m³ TWA

ACGIH: The American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for 1,1,1-trichloroethane of 350 ppm, 1910 mg/m³ TWA; 450 ppm, 2460 mg/m³ STEL; Appendix A4 - Not Classifiable as a Human Carcinogen

NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) for 1,1,1-trichloroethane of 350 ppm, 1900 mg/m³ Ceiling (15 Minutes); Appendix C - Supplementary Exposure Limits (chloroethanes)

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Australia [7]

Safe Work Australia: Safe Work Australia has set an 8-hour Time Weighted Average (TWA) concentration of 100ppm or 555mg/m³ for 1,1,1-trichloroethane for a 40-hour work week.

The short-term exposure limits are 200ppm or 1110mg/m³, which is the time-weighted average maximum airborne concentration of 1,1,1-trichloroethane calculated over a 15-minute period.

REFERENCE

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Gossip

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Sex and the single gene: new research shows a genetic 'master switch' determines sex in most animals

2023-04-20

In humans and other animals, sex is usually determined by a single gene. However, there are claims that in some species, such as platyfish, it takes a whole "parliament" of genes acting together to determine whether offspring develop as a male or female.

In a new analysis, we took a close look at these claims. We found they describe abnormal situations, such as hybrids between two species with different sex-determining systems, or when one sex system is in the process of replacing another.

We conclude that sex is normally determined by a single gene. Evolutionary theory suggests this is the most stable state of affairs, as it ensures a 1:1 ratio of male and female animals.

The human 'master switch' for sex

In mammals, females have two X chromosomes, whereas males have an X and a Y. The Y chromosome bears a gene called SRY, which acts as a "master switch": an XY embryo, carrying SRY, develops into a biological male, and an XX embryo, lacking SRY, develops into a biological female.

This makes the inheritance of sex simple. Females make eggs, which carry a single X chromosome, while males make sperm, half carrying an X and half carrying a Y.

Random fusion of eggs and sperm delivers half XX females and half XY males, for a 1:1 sex ratio.

Sex in other vertebrates

Among animals with backbones (vertebrates), there is a huge variety of systems that determine sex. However, they usually come down to the action of a single gene.

Many fish, frogs and some turtles have systems like ours, in which a male-dominant gene on the Y chromosome directs testis development. Some vertebrates have the opposite – a female-dominant gene on the X chromosome.

Other vertebrates use a dosage difference of a single gene. In birds, males have two copies of a Z chromosome with the sex-determining gene DMRT1. Females have a single Z and a W chromosome that lacks DMRT1.

Surprisingly, many different genes act as the master switch in different species. But they all act by triggering the same male or female differentiation pathway.

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Sex depends on DMRT1 dosage: two copies in ZZ males, versus one in ZW females.

Surprisingly, many different genes act as the master switch in different species. But they all act by triggering the same male or female differentiation pathway.

These single-gene systems deliver equal numbers of males and females, which theory says is the optimal balance for a stable system. If the ratio favours one sex, individuals that produce more of the other sex will leave more descendants and their genes will spread until a 1:1 ratio is achieved.

Some exceptional species

Some aquarium fish have more complex systems. Genetic crosses in platyfish appear to show two or more genes that determine male or female development; the sea bass seems to have at least three sex genes.

Some frogs and lizards seem to determine sex using two or more sex genes.

Then there are species with two or more pairs of sex chromosomes. The platypus has five X and five Y chromosomes. Is there a sex gene on each Y? How will a poor baby platypus know how to develop if it gets three Ys and two Xs from its dad?

And what about species, like the African clawed toad, which have two copies of their whole genome, so should have two pairs of sex chromosomes and sex genes?

So there are lots of exceptional species that seem to have multiple sex chromosomes and sex genes in defiance of the expectation that only a single sex gene can produce a stable system.

Polygenic sex – is there any such thing?

In species where we cannot find a single master switch gene, it is common to talk about "polygenic sex". But how robust are these examples?

In our recent paper we examine classic examples and recent claims for polygenic sex determination. We conclude the few systems that qualify represent abnormal and transient situations.

Multiple sex chromosomes need not mean multiple sex genes. In the platypus, all five Y chromosomes move together into sperm, and a single gene on the smallest Y directs male development. The African clawed toad

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solved the problem of its doubled genome by evolving a novel female-determining gene on a newly minted W chromosome.

In several systems, two sex genes are detected, but they control different steps of the same pathway that are regulated by a single master gene.

In some of the classic fish systems, like platyfish, the different variants all spring from the same chromosome, suggesting sex is controlled by different variants of the same gene. A Japanese frog has different sex chromosomes on different islands, but they are all variants of the same chromosome.

Other examples suggest systems in transition. Sea bass shows different frequencies of variants over its range. There are signs of a new system gradually replacing an old one in a European frog.

The zebrafish is particularly interesting. Strains bred independently in laboratories for 30 or 40 years have aberrant sex ratios and multiple sex genes.

But it turns out wild zebrafish have a regular ZW sex chromosome system. Lab stocks independently lost their W chromosome during lab breeding. All the lab fish are ZZ, and sex of the hatchlings is determined by weaker sex-differentiating genes that were lurking in the background.

Winning the war of the sex genes

Many “polygenic” systems turn out to be hybrids between two species. Species hybrids often have problems with reproduction, such as sterility or skewed sex ratios.

Their problem is incompatibility of different sex chromosomes and sex genes. If an XY male mates with a ZW female, offspring have all sorts of combinations of sex genes.

Incompatibilities can play out differently. For instance, two species of cichlid fish living side by side in Lake Malawi in Africa have unrelated XY and ZW systems. In their XYZW offspring, the W partially overrides the male determining effect of the Y, so XYZW fish have intersex traits. But, in another species combination, the W gene triumphs and XYZW fish are fertile females.

Species hybrids may reveal many genes with major and minor effects on sex determination. For instance, crossing two catfish species revealed seven male-associated and 17 female-associated genes on different chromosomes.

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So there are certainly species where two or more genes act together or in opposition. However, in the long term there is strong selection for one or the other to gain the upper hand. This will turn an inefficient polygenic system into a single-gene system, delivering fertile males and females in a 1:1 ratio.

The Conversation, 20 April 2023

<https://conversation.com>

Orb weaver spiders change their glue without changing genes

2023-04-18

Orb weaver spiders' webs are the stuff of legend. One night you might have a clear doorway, and the next morning you've got an entire intricate lattice of web ready to accidentally walk into.

But scientists are zooming in on one particularly sticky part of the web – the glue – to understand how different spider species quickly change their formula

“Discovering the sticky protein components of biological glues opens the doors to determining how material properties evolve,” said Dr Nadia Ayoub, a Washington and Lee University evolutionary biologist.

“Spider silk fibres and glues represent a fantastic model for answering such questions since they are primarily made of proteins and proteins are encoded by genes.”

A spider's web needs to be perfectly aligned to their environment. The web has a stiff frame and radial lines to absorb the impact of any flying insects, but there's also a glue substance covering the web which traps the creatures. This glue absorbs water from the air. If the weather is humid the glue needs to be different to an area which is dry.

To see what is going on, researchers looked at two species of orb weaver spiders – *Argiope argentata* — which lives in dry environments — and *Argiope trifasciata*, which lives in humid environments.

The researchers collected webs from the wild and also got the spiders to create webs in the lab. Both spider species had equivalent diets, and droplets of the glue were tested between wild and lab grown to ensure the lab wasn't changing the properties.

Good glue equals a good meal.

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The team found that it mostly wasn't the genes themselves that were different between the species as both species had very similar protein components. But the differences between the two webs were stark.

A. argentata's glue droplets were smaller than *A. trifasciata's*, and they absorbed less water as humidity increased.

The 'cores' of the protein also were different. *A. argentata's* protein cores were smaller and absorbed less water from the atmosphere.

A. argentata thread glue droplets were also generally more closely spaced and stickier.

"Despite the dramatic differences in material properties, the two species share most of their protein components," said one of the researchers, Dr Brent Opell of Virginia Tech.

"The sequences of these proteins are also similar between species, but the relative abundance of individual proteins differs. Modifying the ratios of proteins is likely a rapid mechanism to adjust material properties of biological glues."

The researchers only looked at two species, so more species will need to be investigated before we can confirm this is the case for all orb weavers.

Cosmos, 18 April 2023

<https://cosmosmagazine>

New report warns about human health risks from PVC pipes used in drinking water systems

2023-04-18

A report from a coalition of U.S. environmental advocacy groups has warned of the health risks of PVC plastic and urged public officials against using the material in community drinking water pipes.

PVC is made with vinyl chloride, the same hazardous material released in the fiery train derailment that triggered a public health and environmental crisis in East Palestine, Ohio. It's also a known carcinogen and endocrine disruptor.

Yet, because of its relatively low cost, PVC – polyvinyl chloride – has become a popular option for communities replacing old drinking water pipes and, in particular, the lead pipes and service lines that carry their own public health risks. In 2021, the Biden administration allocated \$15

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billion through the U.S. Environmental Protection Agency's Drinking Water State Revolving Fund for communities coast to coast to replace lead service lines.

The report's contributors criticized the EPA for issuing no guidance on which piping materials should be used for such projects.

"In the months and years ahead, this new federal money will be flowing to state and local governments, and it's unfortunate the EPA is not providing any guidance on what is a safe substitute for lead service line pipes," said Judith Enck, a former regional EPA administrator and the president of Beyond Plastics, a nonprofit environmental group based at Bennington College, Vermont.

Beyond Plastics released the report Tuesday along with two other nonprofit environmental advocacy groups: Environmental Health Sciences and the Plastic Pollution Coalition.

The EPA did not immediately respond to a request for comment.

Enck said the report raises legitimate concerns about the health consequences from chemicals in PVC pipes leaching into the drinking water. Instead of PVC or CPVC – chlorinated polyvinyl chloride – Enck said, communities should use safer alternatives like stainless steel or copper even if those materials cost more.

"When people say that plastics is cheap, they are dead wrong," Enck said at a virtual news conference Tuesday. "The price is paid widely and for decades through health care costs and tax dollars."

The Consumer Product Safety Commission banned the use of vinyl chloride in aerosols in 1974, but the chemical is still used in other products and remains a key component in PVC pipes.

The global PVC pipe market is on the rise, fueled in part by the increasing demand for PVC pipes in water, sewage and irrigation projects, according to several industry trend reports.

PVC was cited as the preferred material for water infrastructure projects in a 2021 survey of more than 200 contractors, engineer and municipal officials by the Accountability Information Management, a marketing research company. Respondents said they anticipate using PVC pipes in nearly 65% of all water projects.

But not all communities are turning to PVC.

Millions of Americans still drink unsafe tap water. Here's why.

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For its lead service line replacement project, the city of Troy, New York, opted instead for copper, said Troy's deputy director of public information, Frank Sainato.

"We only use copper, because copper is tried and true," he said. "It may cost more, but public safety is always worth the extra expense."

Sainato said the city expects to break ground this year.

Rochester, New York, just three hours to the west, also avoided PVC for its lead service line replacement program, said public information director Barbara Pierce.

"The City of Rochester does not use PVC or CPVC for water service material, instead it uses copper and cross-linked polyethylene pipe, which does not contain polyvinyl chloride or vinyl chloride," Pierce said in an email to USA TODAY.

"All water service pipe the City uses – along with all other materials used in the water system – is certified for use in potable water systems by the National Sanitation Foundation, AWWA, and approved for use by both USEPA and NYSDOH."

A woman who answered the phone at Uni-Bell PVC Pipe Association – a national nonprofit organization that touts itself as "the authoritative source of information on PVC water, sewer, and reclaimed water pipe" – said nobody there would want to comment on the report.

In a statement to USA TODAY, a spokesman for the American Chemistry Council did not specifically dispute the report but said that PVC has 35-45% "less lifecycle greenhouse gas emissions compared to iron pipes, and PVC pipes used for delivering drinking water are certified by NSF International to conform to EPA safety regulations."

In addition to highlighting the health risks from PVC chemicals leaching into the water supply, the report noted the health and environmental consequences involved in the production of vinyl chloride used to make PVC.

The East Palestine train derailment is emblematic of that risk, said Mike Schade, a program director of the environmental health research and advocacy organization Toxic-Free Future, during the virtual press conference.

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Since the derailment Feb. 3, people living in and around East Palestine have reported numerous health symptoms including headaches, sore throats, eye irritation and coughing.

Schade said people who live near facilities involved in the production of vinyl chloride face those risks and more. These communities, he said, are disproportionately low-income and minority.

"It is deeply troubling that more than 10 billion pounds of vinyl chloride are produced in a year, and low-income communities and communities of color are bearing the brunt of these harmful exposures," Schade said. "We all know that lead is toxic, but so is PVC pipe, which is known as the poison plastic. If EPA is truly committed to environmental justice, they would ban local and state governments from using PVC pipe to replace lead service lines."

USA Today, 18 April 2023

<https://usatoday.com>

"It's just mind boggling." More than 19,000 undersea volcanoes discovered

2023-04-19

The U.S. submarine fleet's biggest adversary lately hasn't been Red October. In 2005, the nuclear-powered USS San Francisco collided with an underwater volcano, or seamount, at top speed, killing a crew member and injuring most aboard. It happened again in 2021 when the USS Connecticut struck a seamount in the South China Sea, damaging its sonar array.

With only one-quarter of the sea floor mapped with sonar, it is impossible to know how many seamounts exist. But radar satellites that measure ocean height can also find them, by looking for subtle signs of seawater mounding above a hidden seamount, tugged by its gravity. A 2011 census using the method found more than 24,000. High-resolution radar data have now added more than 19,000 new ones. The vast majority—more than 27,000—remain uncharted by sonar. "It's just mind boggling," says David Sandwell, a marine geophysicist at the Scripps Institution of Oceanography, who helped lead the work.

Published this month in Earth and Space Science, the new seamount catalog is "a great step forward," says Larry Mayer, director of the University of New Hampshire's Center for Coastal and Ocean Mapping. Besides

New seamount maps could aid in studies of ecology, plate tectonics, and ocean mixing

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posing navigational hazards, the mountains harbor rare-earth minerals that make them commercial targets for deep-sea miners. Their size and distribution hold clues to plate tectonics and magmatism. They are crucial oases for marine life. And they are pot-stirrers that help control the large-scale ocean flows responsible for sequestering vast amounts of heat and carbon dioxide, says John Lowell, chief hydrographer of the National Geospatial-Intelligence Agency (NGA), which runs the U.S. military's satellite mapping efforts. "The better we understand the shape of the sea floor, the better we can prepare [for climate change]."

After the USS San Francisco accident, Sandwell and his colleagues secured funding from the Navy and NGA to hunt for seamounts with satellites. They identified thousands, including 700 particularly shallow ones that posed hazards to submarines. But the team knew its first catalog was far from complete. Now, armed with data from high-resolution radar satellites, including the European Space Agency's CryoSat-2 and SARAL from the Indian and French space agencies, the team can detect seamounts just 1100 meters tall—close to the lower limit of what defines a seamount, Sandwell says.

Seamounts often occur in chains formed as tectonic plates ride over stationary plumes of hot rock rising from the mantle. As a result, the catalog will pay immediate dividends for studies of Earth's interior, says Carmen Gaina, a geophysicist at the Queensland University of Technology. It has already identified new seamounts in the northeast Atlantic Ocean that could help track the evolution of the mantle plume that feeds Iceland's volcanoes. The survey also spotted seamounts near a ridge in the Indian Ocean where fresh crust is made as tectonic plates spread apart. They suggest a surprising amount of volcanism in a region once thought to be magma starved, Gaina says.

To biologists, seamounts' steep slopes resemble crowded, boisterous skyscrapers for corals and other marine life. "They're oases for biodiversity and biomass," says Amy Baco-Taylor, a deep-sea biologist at Florida State University. Whales use them as waypoints. But biologists debate the role seamounts play in marine biodiversity: Are they home to genetically distinct species, like remote islands? Or do they serve as stepping stones for life to hopscotch through the oceans? By pushing up the density of seamounts, the new maps could strengthen the argument for the latter, Baco-Taylor says.

They will also boost efforts to protect biodiversity in international waters under a new marine protection treaty. "We can't protect the things if we

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don't know they're there," says Chris Yesson, a marine biologist at the Zoological Society of London's Institute of Zoology. The maps will provide a practical payoff, Yesson adds: "We won't waste our time as much." Some of his colleagues, he says, once traveled to the Indian Ocean to study a seamount that turned out to be a phantom created by an error in pre-sonar depth records.

Nowhere will the new maps be as important as in understanding the ocean's globe-girdling conveyor belt of currents. The currents ferry heat from the equator to the poles, where the water cools and gains density until it plunges downward, carrying heat and carbon dioxide into the abyss. But the flip side of this perpetual motion machine—deep ocean waters defying gravity and rising upward—has long been a mystery. The "upwelling" was once thought to happen evenly across the ocean, driven by turbulent waves at boundaries between deep ocean layers of different densities. Now, researchers believe it is concentrated at seamounts and ridges. "There's a zoo of interesting things that happen when you have topography," says Brian Arbic, a physical oceanographer at the University of Michigan, Ann Arbor.

When ocean currents curl around seamounts, they create turbulent "wake vortices" that can provide the energy to push cold water up, says Jonathan Gula, a physical oceanographer at the University of Western Brittany. In unpublished research, Gula and co-authors have found that these wake vortices make seamounts the leading contributor to upward ocean mixing, and a central player in climate. Since the team relied on the old Scripps catalog, not the new one, the effect of the seamounts is probably even larger, Gula adds.

The seamount catalog is sure to expand further with Seabed 2030, an international project to accelerate high-resolution sonar mapping that Mayer is helping lead. But space surveys will improve too. NASA's Surface Water and Ocean Topography satellite, launched in December 2022, can measure the height of a water surface to within a couple of centimeters. Better remote sensing would be welcome, given the cost of sonar mapping voyages, Mayer says. "I would love to see it threaten what I do."

Science, 19 April 2023

<https://science.org>

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Cutting-edge advances in cancer treatment are underway. Here are 3 that could change lives.

2023-04-20

What if radiation treatments could be given in a handful of seconds rather than weeks of treatments?

What if surgeons could actually see tumor cells rather than simply hoping they got rid of them all?

What if scientists could come up with new ways to detect, treat and understand tumors?

These were among some of the ideas presented this week in Orlando, Florida, at the American Association for Cancer Research annual conference, where more than 6,500 scientists shared their work and their hopes for improving the lives of cancer patients.

Work against cancer has continued over the last three years, despite the pandemic, said Dr. Robert Vonderheide, the conference's program committee chair. The thousands of presentations and 20,000-person turnout should convince people of that.

Obviously, lots of the research is worth public attention. But with Vonderheide's guidance, USA TODAY picked three ideas that seemed among the most surprising and hopeful, the kinds of approaches that have the potential to transform cancer treatment and patients' lives.

The first is "flash" radiation, which concentrates weeks of treatments into a few days; the second, an imaging technology that lights up cancer cells to help surgeons track them down.

"Two of the most fundamental tools, cancer surgery and cancer radiation, are undergoing before our eyes fundamental changes in their technology," said Vonderheide, who directs the Abramson Cancer Center at the University of Pennsylvania. "They are each promising better success."

A third line of research is providing insights into the role of the nervous system in cancer, which could eventually be used to help patients sleep better, heal faster and live longer.

Researchers typically focus on a tumor, but there are "systemic signals that might tell us how best to treat a patient or that a patient actually has a lurking cancer," Vonderheide said.

The pandemic didn't slow down scientists, who are making progress in cancer treatment and research. Exciting advances involves radiation, tumor surgery and new insights into the nervous system.

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Like the immune system, which has increasingly been manipulated to help fight cancer over the last decade, the nervous system monitors the body and remembers what it encounters.

"The immune system is probably the first system to know that cancer exists. And probably the nervous system is the next one," he said. "Maybe there's new inroads in early detection if we focus on neurological health and immune health."

None of these new approaches is readily available yet, but Vonderheide thinks they're among the advances worth watching.

Flash radiation could mean cancer treatment in seconds, not weeks

At least half of patients with solid tumors endure radiation at some point during their treatment. Radiation typically takes about 15 minutes, though sessions can last an hour or more and are scheduled every weekday for three to nine weeks – requiring a total of 15 to 40 visits.

Patients may suffer skin burns, dry mouth, difficulties eating and swallowing, and exhaustion. They must upend their lives and often a loved one's to get to a clinic so many times.

Radiation therapy is traditionally delivered in small doses over weeks so it can efficiently kill tumor cells while being less toxic to surrounding healthy tissue, said Constantinos Koumenis, a professor of radiation biology at the University of Pennsylvania's Perelman School of Medicine.

But as many radiation patients can attest, treatments still do plenty of damage to normal tissue.

Instead, Koumenis and dozens of other research teams have been testing "flash radiation," which uses ultra-high dose rate beams of energy to zap tumor cells. Patients might get the same amount of radiation in just two to four sessions of less than 1 second each.

"The vulnerability of the tumor cells is essentially the same," Koumenis said. "What's different is the normal tissue is more resistant to the flash radiation."

Proton beam machines are gigantic, hugely expensive and not widely available, he said, but they can also deliver flash radiation at 1,000 times the dose rate of conventional radiotherapy. While the X-rays used in conventional radiation damage normal tissue on the way to and from the tumor, proton beams are stopped by the tumor, so only affect healthy tissue in one direction, he said.

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Koumenis and teams in Europe have been testing flash radiation in pets. They've shown that they can efficiently and safely deliver these high-dose rate beams in dogs and cats with sarcomas and head and neck cancers.

The first human trial, which started about two years ago, showed that the approach was safe and feasible in 10 patients whose cancer had spread to their bones. Additional human trials are ongoing or are being planned in the next two to three years.

Many more studies are needed, Koumenis said, but he hopes using flash radiation in head and neck cancer, for instance, might better preserve the taste buds and salivary glands, enabling the patient to maintain the ability to taste and swallow.

"We could keep the same dose, achieve the same control of the tumor, but now spare these senses," he said.

In other cases, when the radiation isn't aimed at critical organs, patients might be able to tolerate higher doses "and perhaps achieve better control of the tumor and better survival because we're not causing unacceptable side effects," Koumenis said.

"In my 25 years in radiobiology research, this is the most excited we've been in this field."

New imaging could help surgeons remove more of the tumor

When surgeons go to take out a tumor, they use their instinct and years of experience to know when they've cut out enough. Then they send frozen slides to the pathology lab to quickly assess if they've gone safely beyond the tumor, creating a negative or clean margin.

But time and again, patients whose surgeons thought they got everything find out they didn't.

"Positive margins kill people," said Dr. Eben Rosenthal, chair of the Department of Otolaryngology at Vanderbilt University in Nashville, Tennessee. "We do surgery the same way we did 30 years ago ... It's disappointing to me as a surgeon."

Rosenthal is at the forefront of an effort to literally highlight tumor cells, offering surgeons an additional way to identify and eliminate cancer.

By adding dyes to therapies that hone in on cancer cells, a surgeon can get a better look at the tumor as it sits in the body, identifying tumors too small to be felt or seen with the naked eye.

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Once a tumor is removed, the dyed cells can help surgeons assess what part to send to pathology, avoiding the false sense of security that can come from sampling the wrong bit of tissue or cutting out more healthy cells than necessary – from, say, the nerves, tongue or brain, Rosenthal said.

"It tells you very quickly where to look," he said.

But Rosenthal said the effort he started in 2010 has been mostly ad hoc, combining existing equipment and medication. "Literally, we're just throwing things together that are not really intended for that purpose," he said.

The approval process has been a challenge, he said, because no one stands to make a lot of money from this procedure.

"I would love to see this developed in a way that would really help patients," he said. "My goal is to show value, so that at some point when a company is able to get off the ground, we can know (it will work)."

Manipulating the nervous system to fight cancer

Growing a tumor is a lot like growing a new organ, according to Jeremy Borniger, an assistant professor at the Cold Spring Harbor Laboratory on New York's Long Island.

It may look like a mass of cells, but a tumor is fed by blood vessels, communicates with the immune system, and like any other organ, connects to the body's nervous system.

For decades, scientists have explored ways to treat cancer by manipulating a tumor's blood supply and changing the way it interacts with the immune system.

Borniger is part of a burgeoning effort to focus on the role nerves play in cancer.

"They're not just playing a passive role," he said. "They're important for all phases of cancer development from initiation all the way through to therapeutic resistance and responses to therapy."

Many people with cancer suffer from chronic fatigue, sleep disruption, appetite changes and brain fog. These are all problems of the nervous system, said Borniger, who's been working to figure out whether these symptoms stem from cancer therapy or cancer itself.

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Studies in brain tumors have shown that cancer can affect brain circuits – and the tumors that tinker more are more dangerous. How common it is for nerves to directly talk to other types of cancer cells is one of the questions scientists are now asking, Borniger said.

But it's already clear that when treatments block the communication between nerve and tumor cells, it "drastically alters" the tumor's growth, cancer's spread within the body and its response to treatment.

"It's really exciting that we can mess with one tiny nucleus in the brain and have such a strong effect on physiology and tumor growth," Borniger said. "The idea will be how linked are these things and what are the right knobs and dials to turn that we can restore this normal functioning so that we can block the bad signaling that promote cancer."

So far, most of this work has been in animals, but early trials are beginning, particularly with already-approved medications like beta blockers that might affect the release of chemicals from the nervous system even in tumors like breast cancer.

Future treatments, Borniger said, might include electrical stimulation to better understand and directly affect the body's wiring system, adding "good signals" to counteract the bad.

The bottom line, Borniger said, is that tumors are not floating in a vacuum, but integrated into the body's systems.

"What's becoming more evident is we need to start listening to how the body is responding to things and not just what's happening in isolation," he said. "One of the best ways we can listen to what's going on is by tapping into the nervous system. Its function is to figure out what's going on and to try and fix the problem."

USA Today, 20 April 2023

<https://usatoday.com>

Contamination Crisis: Arctic Ice Algae Heavily Contaminated With Microplastics

2023-04-21

The alga *Melosira arctica*, which grows under Arctic sea ice, contains ten times as many microplastic particles as the surrounding seawater. This concentration at the base of the food web poses a threat to creatures that feed on the algae at the sea surface. Clumps of dead algae also transport

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the plastic with its pollutants particularly quickly into the deep sea – and can thus explain the high microplastic concentrations in the sediment there. Researchers led by the Alfred Wegener Institute have now reported this in the journal *Environmental Science and Technology*.

It is a food lift for bottom-dwelling animals in the deep sea: the alga *Melosira arctica* grows at a rapid pace under the sea ice during spring and summer months and forms metre-long cell chains there. When the cells die and the ice to whose underside they adhere melts, they stick together to form clumps that can sink several thousand metres to the bottom of the deep sea within a single day. There they form an important food source for bottom-dwelling animals and bacteria.

In addition to food, however, these aggregates also transport a dubious cargo into the Arctic deep sea: microplastics. A research team led by biologist Dr Melanie Bergmann from the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) has now published this in the journal *Environmental Science and Technology*.

"We have finally found a plausible explanation for why we always measure the largest amounts of microplastics in the area of the ice edge, even in deep-sea sediment," Melanie Bergmann reports. Until now, the researchers only knew from earlier measurements that microplastics concentrate in the ice during sea ice formation and are released into the surrounding water when it melts.

"The speed at which the Alga descends means that it falls almost in a straight line below the edge of the ice. Marine snow, on the other hand, is slower and gets pushed sideways by currents so sinks further away. With the *Melosira* taking microplastics directly to the bottom, it helps explain why we measure higher microplastic numbers under the ice edge," explains the AWI biologist.

On an expedition with the research vessel *Polarstern* in the summer of 2021, she and a research team collected samples of *Melosira* algae and the surrounding water from ice floes. The partners from Ocean Frontier Institute (OFI), Dalhousie University and the University of Canterbury then analysed these in the laboratory for microplastic content. The surprising result: the clumps of algae contained an average of $31,000 \pm 19,000$ microplastic particles per cubic metre, about ten times the concentration of the surrounding water.

"The filamentous algae have a slimy, sticky texture, so it potentially collects microplastic from the atmospheric deposition on the sea, the seawater

Melosira arctica has ten times higher concentration of plastic particles than surrounding seawater.

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itself, from the surrounding ice and any other source that it passes. Once entrapped in the algal slime they travel as if in an elevator to the seafloor, or are eaten by marine animals," explains Deonie Allen of the University of Canterbury and Birmingham University who is part of the research team.

Since the ice algae are an important food source for many deep-sea dwellers, the microplastic could thus enter the food web there. But it is also an important food source at the sea surface and could explain why microplastics were particularly widespread among ice-associated zooplankton organisms, as an earlier study with AWI participation shows. In this way, it can also enter the food chain here when the zooplankton is eaten by fish such as polar cod and these are eaten by seabirds and seals and these in turn by polar bears.

The detailed analysis of plastic composition showed that a variety of different plastics are found in the Arctic, including polyethylene, polyester, polypropylene, nylon, acrylic and many more. In addition to various chemicals and dyes, this creates a mix of substances whose impact on the environment and living creatures is difficult to assess.

"People in the Arctic are particularly dependent on the marine food web for their protein supply, for example through hunting or fishing. This means that they are also exposed to the microplastics and chemicals contained in it. Microplastics have already been detected in human intestines, blood, veins, lungs, placenta and breast milk and can cause inflammatory reactions, but the overall consequences have hardly been researched so far," reports Melanie Bergmann.

"Micro and nano plastics have basically been detected in every place scientists have looked in the human body and within a plethora of other species. It is known to change behaviours, growth, fecundity and mortality rates in organisms and many plastic chemicals are known toxins to humans," says Steve Allen, OFI Dalhousie University, a research team member.

Moreover, the Arctic ecosystem is already threatened by the profound environmental upheavals caused by the climate crisis. If the organisms are now additionally exposed to microplastics and the chemicals they contain, it can weaken them further.

"So, we have a combination of planetary crises that we urgently need to address effectively. Scientific calculations have shown that the most effective way to reduce plastic pollution is to reduce the production of new plastic," says the AWI biologist and adds: "This should therefore

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definitely be prioritised in the global plastics agreement that is currently being negotiated." That is why Melanie Bergmann is also accompanying the next round of negotiations, which will begin in Paris at the end of May.

Sci Tech Daily, 21 April 2023

<https://scitechdaily.com>

A New Kind of Symmetry Shakes Up Physics

2023-04-18

It's not an exaggeration to say that every major advance in physics for more than a century has turned on revelations about symmetry. It's there at the dawn of general relativity, in the birth of the Standard Model, in the hunt for the Higgs.

For that reason, research across physics is now building to a crescendo. It was touched off by a 2014 paper, "Generalized Global Symmetries," which demonstrated that the most important symmetries of 20th-century physics could be extended more broadly to apply in quantum field theory, the basic theoretical framework in which physicists work today.

This reformulation, which crystallized earlier work in the area, revealed that disparate observations physicists had made in the past 40 years were really manifestations of the same lurking symmetry. In doing so, it created an organizing principle that physicists could use to categorize and understand phenomena. "That's really a stroke of genius," said Nathaniel Craig, a physicist at the University of California, Santa Barbara.

The principle identified in the paper came to be known as "higher symmetries." The name reflects the way the symmetries apply to higher-dimensional objects such as lines, rather than lower-dimensional objects such as particles at single points in space. By giving the symmetry a name and language and by identifying places it had been observed before, the paper prompted physicists to search for other places it might appear.

Physicists and mathematicians are collaborating to work out the mathematics of these new symmetries — and in some cases they're discovering that the symmetries work like a one-way street, a notable contrast to all other symmetries in physics. At the same time, physicists are applying the symmetries to explain a wide range of questions, from the decay rate of certain particles to novel phase transitions like the fractional quantum Hall effect.

So-called "higher symmetries" are illuminating everything from particle decays to the behavior of complex quantum systems.

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“By putting a different perspective on a known sort of physical problem, it just opened up a huge new area,” said Sakura Schafer-Nameki, a physicist at the University of Oxford.

Symmetry Matters

To understand why a paper that merely points out the breadth of lurking symmetries can make such a big impact, it helps to first understand how symmetry makes life easier for physicists. Symmetry means fewer details to keep track of. That’s true whether you’re doing high-energy physics or laying bathroom tile.

The symmetries of a bathroom tile are spatial symmetries — each can be rotated, flipped upside down or moved to a new spot. Spatial symmetries play an important simplifying role in physics too. They’re prominent in Einstein’s theory of space-time — and the fact that they pertain to our universe means physicists have one less thing to worry about.

“If you’re doing an experiment in a lab and you rotate it, that shouldn’t change your answer,” said Nathan Seiberg, a theoretical physicist at the Institute for Advanced Study in Princeton, New Jersey.

The symmetries that are most important in physics today are subtler than spatial symmetries, but they carry the same meaning: They’re constraints on the ways that you can transform something to ensure that it’s still the same.

In an epochal insight in 1915, the mathematician Emmy Noether formalized the relationship between symmetries and conservation laws. For example, symmetries in time — it doesn’t matter if you run your experiment today or tomorrow — mathematically imply the law of conservation of energy. Rotational symmetries lead to the law of conservation of angular momentum.

“Every conservation law is associated with a symmetry, and every symmetry is associated with a conservation law,” Seiberg said. “It’s well understood and it’s very deep.”

This is just one of the ways that symmetries help physicists understand the universe.

Physicists would like to create a taxonomy of physical systems, classifying like with like, in order to know when insights from one can be applied to another. Symmetries are a good organizing principle: All systems exhibiting the same symmetry go in the same bucket.

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Furthermore, if physicists know a system possesses a given symmetry, they can avoid a lot of the mathematical work of describing how it behaves. The symmetries constrain the possible states of the system, which means they limit the potential answers to the complicated equations that characterize the system.

“Typically, some random physical equations are unsolvable, but if you have enough symmetry, then the symmetry constrains the possible answers. You can say the solution must be this because it’s the only symmetric thing,” said Theo Johnson-Freyd of the Perimeter Institute for Theoretical Physics in Waterloo, Canada.

Symmetries convey elegance, and their presence can be obvious in hindsight. But until physicists identify their influence, related phenomena can remain distinct. Which is what happened with a host of observations physicists made starting in the early 1970s.

Fields and Strings

The conservation laws and symmetries of 20th-century physics take pointlike particles as their primary objects. But in modern quantum field theories, quantum fields are the most basic objects, and particles are just fluctuations in these fields. And within these theories it’s often necessary to go beyond points and particles to think about one-dimensional lines, or strings (which are conceptually distinct from the strings in string theory).

In 1973, physicists described an experiment that involved placing a superconducting material between poles of a magnet. They observed that as they increased the strength of the magnetic field, particles arranged themselves along one-dimensional superconducting threads running between the magnetic poles.

The next year Kenneth Wilson identified strings — Wilson lines — in the setting of classical electromagnetism. Strings also appear in the way the strong force acts among quarks, which are the elementary particles that make up a proton. Separate a quark from its antiquark, and a string forms between them that pulls them back together.

The point is that strings play an important role in many areas of physics. At the same time, they’re mismatched to traditional conservation laws and symmetries, which are expressed in terms of particles.

“The modern thing is to say we’re not only interested in the properties of points; we’re interested in the properties of lines or strings, and there can also be conservation laws for them,” said Seiberg, who co-wrote the

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2014 paper along with Davide Gaiotto of the Perimeter Institute, Anton Kapustin of the California Institute of Technology, and Brian Willett, who was at the time a postdoc at the Institute for Advanced Study.

The paper presented a way of measuring charge along a string and establishing that charge remains conserved as the system evolves, just as total charge is always conserved for particles. And the team did it by shifting their attention from the string itself.

Seiberg and his colleagues imagined the one-dimensional string as being surrounded by a surface, a two-dimensional plane, so that it looked like a line drawn on a sheet of paper. Instead of measuring charge along the string, they described a method for measuring the total charge across the surface surrounding the string.

“The really new thing is you emphasize the charged object, and you think about [surfaces] that surround it,” Schafer-Nameki said.

The four authors then considered what happens to the surrounding surface as the system evolves. Maybe it warps or twists or otherwise changes from the completely flat surface they measured originally. Then they demonstrated that even as the surface deforms, the total charge along it remains the same.

That is, if you measure charge at every point on a piece of paper, then distort the paper and measure again, you’ll get the same number. You can say that charge is conserved along the surface, and since the surface is indexed to the string, you can say it’s conserved along the string, too — regardless of what kind of string you started with.

“The mechanics of a superconducting string and a strong-force string are completely different, yet the mathematics of these strings and the conservation [laws] are exactly the same,” Seiberg said. “That’s the beauty of this whole idea.”

Equivalent Surfaces

The suggestion that a surface remains the same — has the same charge — even after it’s deformed echoes concepts from the mathematical field of topology. In topology, mathematicians classify surfaces according to whether one can be deformed into the other without any ripping. According to this viewpoint, a perfect sphere and a lopsided ball are equivalent, since you can inflate the ball to get the sphere. But a sphere and an inner tube are not, as you’d have to gash the sphere to get the inner tube.

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Similar thinking about equivalence applies to surfaces around strings — and by extension, the quantum field theories inside of which those surfaces are drawn, Seiberg and his co-authors wrote. They referred to their method of measuring charge on surfaces as a topological operator. The word “topological” conveys that sense of overlooking insignificant variations between a flat surface and a warped one. If you measure the charge on each, and it comes out the same, you know that the two systems can be smoothly deformed into each other.

Topology allows mathematicians to look past minor variations to focus on fundamental ways in which different shapes are the same. Similarly, higher symmetries provide physicists with a new way of indexing quantum systems, the authors concluded. Those systems may look completely different from each other, but in a deep way they might really obey the same rules. Higher symmetries can detect that — and by detecting it, they allow physicists to take knowledge about better-understood quantum systems and apply it to others.

“The development of all these symmetries is like developing a series of ID numbers for a quantum system,” said Shu-Heng Shao, a theoretical physicist at Stony Brook University. “Sometimes two seemingly unrelated quantum systems turn out to have the same set of symmetries, which suggests they might be the same quantum system.”

Despite these elegant insights about strings and symmetries in quantum field theories, the 2014 paper didn’t spell out any dramatic ways of applying them. Equipped with new symmetries, physicists might hope to be able to answer new questions — but at the time, higher symmetries were only immediately useful for re-characterizing things physicists already knew. Seiberg recalls being disappointed that they couldn’t do more than that.

“I remember going around thinking, ‘We need a killer app,’” he said.

From New Symmetries to New Mathematics

To write a killer app, you need a good programming language. In physics, mathematics is that language, explaining in a formal, rigorous way how symmetries work together. Following the landmark paper, mathematicians and physicists started by investigating how higher symmetries could be expressed in terms of objects called groups, which are the main mathematical structure used to describe symmetries.

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A group encodes all the ways the symmetries of a shape or a system can be combined. It establishes the rules for how the symmetries operate and tells you what positions the system can end up in following symmetry transformations (and which positions, or states, can never occur).

Group encoding work is expressed in the language of algebra. In the same way that order matters when you're solving an algebraic equation (dividing 4 by 2 is not the same as dividing 2 by 4), the algebraic structure of a group reveals how order matters when you're applying symmetry transformations, including rotations.

"Understanding algebraic relationships between transformations is a precursor to any application," said Clay Córdova of the University of Chicago. "You can't understand how the world is constrained by rotations until you understand 'What are rotations?'"

By investigating those relationships, two separate teams — one involving Córdova and Shao and one that includes researchers at Stony Brook and the University of Tokyo — discovered that even in realistic quantum systems, there are non-invertible symmetries that fail to conform to the group structure, a feature that every other important type of symmetry in physics fits into. Instead, these symmetries are described by related objects called categories which have more relaxed rules for how symmetries can be combined.

For example, in a group, every symmetry is required to have an inverse symmetry — an operation that undoes it and sends the object it acts on back to where it started. But in separate papers published last year, the two groups showed that some higher symmetries are non-invertible, meaning once you apply them to a system, you can't get back to where you started.

This non-invertibility reflects the way that a higher symmetry can transform a quantum system into a superposition of states, in which it is probabilistically two things at once. From there, there's no road back to the original system. To capture this more complicated way higher symmetries and non-invertible symmetries interact, researchers including Johnson-Freyd have developed a new mathematical object called a higher fusion category.

"It's the mathematical edifice that describes the fusions and interactions of all these symmetries," Córdova said. "It tells you all the algebraic possibilities for how they can interact."

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Higher fusion categories help to define the non-invertible symmetries that are mathematically possible, but they don't tell you which symmetries are useful in specific physical situations. They establish the parameters of a hunt on which physicists then embark.

"As a physicist the exciting thing is the physics we get out of it. It shouldn't just be math for the sake of math," Schafer-Nameki said.

Early Applications

Equipped with higher symmetries, physicists are also reevaluating old cases in light of new evidence.

For example, in the 1960s physicists noticed a discrepancy in the decay rate of a particle called the pion. Theoretical calculations said it should be one thing, experimental observations said another. In 1969, two papers seemed to resolve the tension by showing that the quantum field theory which governs pion decay does not actually possess a symmetry that physicists thought it did. Without that symmetry, the discrepancy disappeared.

But last May, three physicists proved that the 1969 verdict was only half the story. It wasn't just that the presupposed symmetry wasn't there — it was that higher symmetries were. And when those symmetries were incorporated into the theoretical picture, the predicted and observed decay rates matched exactly.

"We can reinterpret this mystery of the pion decay not in terms of the absence of symmetry but in terms of the presence of a new kind of symmetry," said Shao, a co-author of the paper.

Similar reexamination has taken place in condensed matter physics. Phase transitions occur when a physical system switches from one state of matter to another. At a formal level, physicists describe those changes in terms of symmetries being broken: Symmetries that pertained in one phase no longer apply in the next.

But not all phases have been neatly described by symmetry-breaking. One, called the fractional quantum Hall effect, involves the spontaneous reorganization of electrons, but without any apparent symmetry being broken. This made it an uncomfortable outlier within the theory of phase transitions. That is, until a paper in 2018 by Xiao-Gang Wen of the Massachusetts Institute of Technology helped establish that the quantum Hall effect does in fact break a symmetry — just not a traditional one.

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“You can think of [it] as symmetry-breaking if you generalize your notion of symmetry,” said Ashvin Vishwinath of Harvard University.

These early applications of higher and non-invertible symmetries — to the pion decay rate, and to the understanding of the fractional quantum Hall effect — are modest compared to what physicists anticipate.

In condensed matter physics, researchers hope that higher and non-invertible symmetries will help them with the fundamental task of identifying and classifying all possible phases of matter. And in particle physics, researchers are looking to higher symmetries to assist with one of the biggest open questions of all: what principles organize physics beyond the Standard Model.

“I want to get the Standard Model out of a consistent theory of quantum gravity, and these symmetries play a critical role,” said Mirjam Cvetič of the University of Pennsylvania.

It will take a while to fully reorient physics around an expanded understanding of symmetry and a broader notion of what makes systems the same. That so many physicists and mathematicians are joining in the effort suggests they think it will be worth it.

“I have not yet seen shocking results that we didn’t know before, but I have no doubt it’s quite likely this will happen, because this is clearly a much better way of thinking about the problem,” Seiberg said.

Quanta, 18 April 2023

<https://quan>

Networks of silver nanowires seem to learn and remember, much like our brains

2023-04-22

Over the past year or so, generative AI models such as ChatGPT and DALL-E have made it possible to produce vast quantities of apparently human-like, high-quality creative content from a simple series of prompts.

Though highly capable – far outperforming humans in big-data pattern recognition tasks in particular – current AI systems are not intelligent in the same way we are. AI systems aren’t structured like our brains and don’t learn the same way.

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AI systems also use vast amounts of energy and resources for training (compared to our three-or-so meals a day). Their ability to adapt and function in dynamic, hard-to-predict and noisy environments is poor in comparison to ours, and they lack human-like memory capabilities.

Our research explores non-biological systems that are more like human brains. In a new study published in Science Advances, we found self-organising networks of tiny silver wires appear to learn and remember in much the same way as the thinking hardware in our heads.

Imitating the brain

Our work is part of a field of research called neuromorphics, which aims to replicate the structure and functionality of biological neurons and synapses in non-biological systems.

Our research focuses on a system that uses a network of “nanowires” to mimic the neurons and synapses in the brain. These nanowires are tiny wires about one thousandth the width of a human hair. They are made of a highly conductive metal, such as silver, typically coated in an insulating material like plastic.

Nanowires self-assemble to form a network structure similar to a biological neural network. Like neurons, which have an insulating membrane, each metal nanowire is coated with a thin insulating layer.

When we stimulate nanowires with electrical signals, ions migrate across the insulating layer and into a neighbouring nanowire (much like neurotransmitters across synapses). As a result, we observe synapse-like electrical signalling in nanowire networks.

Learning and memory

Our new work uses this nanowire system to explore the question of human-like intelligence. Central to our investigation are two features indicative of high-order cognitive function: learning and memory.

Our study demonstrates we can selectively strengthen (and weaken) synaptic pathways in nanowire networks. This is similar to “supervised learning” in the brain. In this process, the output of synapses is compared to a desired result. Then the synapses are strengthened (if their output is close to the desired result) or pruned (if their output is not close to the desired result).

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We expanded on this result by showing we could increase the amount of strengthening by “rewarding” or “punishing” the network. This process is inspired by “reinforcement learning” in the brain.

We also implemented a version of a test called the “n-back task” which is used to measure working memory in humans. It involves presenting a series of stimuli and comparing each new entry with one that occurred some number of steps (n) ago.

The network “remembered” previous signals for at least seven steps. Curiously, seven is often regarded as the average number of items humans can keep in working memory at one time.

When we used reinforcement learning, we saw dramatic improvements in the network’s memory performance.

In our nanowire networks, we found the formation of synaptic pathways depends on how those synapses have been activated in the past. This is also the case for synapses in the brain, where neuroscientists call it “metaplasticity”.

Synthetic intelligence

Human intelligence is still likely a long way from being replicated.

Nonetheless, our research on neuromorphic nanowire networks shows it is possible to implement features essential for intelligence – such as learning and memory – in non-biological, physical hardware.

Nanowire networks are different from the artificial neural networks used in AI. Still, they may lead to so-called “synthetic intelligence”.

Perhaps a neuromorphic nanowire network could one day learn to have conversations that are more human-like than ChatGPT, and remember them.

The Conversation, 22 April 2023

<https://theconversation.com>

Inadequate Protection: Current Radiation PPE is Failing to Shield Female Healthcare Workers

2023-04-22

In an article published recently in The BMJ, doctors advocate for improved ionizing radiation protection for women in healthcare who are regularly

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exposed to radiation through X-rays and other imaging procedures, in order to reduce their risk of developing breast cancer.

Due to the high sensitivity of breast tissue to radiation and the fact that ionizing radiation is a well-established human carcinogen, there are apprehensions that frequent exposure to ionizing radiation during image-guided procedures could increase the likelihood of female healthcare workers developing breast cancer.

Personal protective equipment (PPE) such as lead gowns are used to shield the body from harmful radiation during these procedures. But studies have shown that current radiation PPE provides inadequate protection to breast tissue as it leaves the area close to the armpit (known as the upper outer quadrant and axilla — the most common site of breast cancer) exposed.

“Providing adequate breast covering PPE could therefore reduce radiation exposure and potentially help prevent breast cancer in female healthcare workers,” write Isobel Pilkington and colleagues.

They acknowledge that measuring the risk of occupational radiation-induced breast cancer in women working in healthcare is challenging, but as the number of female trainees entering these specialties increases, they say “it is essential that the available evidence is considered and equipment provision improved to minimize this risk.”

They point to observational evidence suggesting an increase in breast cancer risk among female US orthopedic surgeons compared with an age-matched female population, and to a small Finnish study showing breast cancer at 1.7 times the expected rate in radiologists, surgeons, and cardiologists compared with female physicians not working with radiation.

In a study using artificial female torsos to measure radiation exposure, researchers found inadequate upper outer quadrant protection and no statistically significant reduction in dose when standard PPE was compared with a torso without PPE.

Occupational radiation exposure has not been identified as a risk factor for male breast cancer. However, the Ionising Radiation Regulations 2017 state that the radiation dose delivered to all workers should be As Low As Reasonably Achievable (ALARA). The most effective way to achieve this, say the authors, is by reducing the duration of exposure, increasing the distance from the source, and shielding all workers with effective PPE.

Adequate protection cannot be guaranteed by standard personal protective equipment for breast tissue; employers should invest in protective gear that ensures the safety of all employees.

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They point to additional protection, such as capped sleeves and axillary wings, that can be worn under standard gowns to protect the upper outer quadrant of the breast, and say the European Society for Vascular Surgery 2023 Clinical Practice Guidelines on Radiation Safety have already recommended female operators consider adopting this extra protection.

“Providing appropriate protection is a legal requirement of an employer, who has a duty of care to all workers exposed to radiation,” they write. “The female breast appears to be particularly vulnerable and it is, therefore, important employers invest in protective equipment that enhances the safety of all their staff.”

Sci Tech Daily, 22 April 2023

<https://scitechdaily.com>

Wind Farms and Birds Are Learning to Coexist

2023-04-21

The Fryslan wind farm in the Netherlands is a sprawling array of 109-meter turbines situated in the deep blue waters of Lake IJssel, north of Amsterdam. Capable of powering 500,000 homes, its sustainability bonafides are obvious. But less immediately apparent are the elements of its design that protect the local ecosystem as well.

Built as the world’s first nature-positive wind farm, Fryslan incorporates a number of innovative measures to reduce collision risks to birds, including radar systems to monitor bird movements through the turbine array, and even several man-made islands that provide breeding habitat for seabirds such as the Common Tern, *Sterna hirundo*.

“For five years, consultancy bureaus will closely monitor the birds, bats, fish, aquatic plants, and shellfish near the island and the wind farm,” said Josephine Hansen, commercial project manager from Siemens Gamesa, in a statement.

The Fryslan development encapsulates how considering wildlife early in the design process can result in wind farms that benefit not just the climate, but also local wildlife. In doing so, Fryslan confronts a central challenge of large-scale renewable power projects: How to generate sustainable energy without harming biodiversity in the process.

The World Wildlife Fund describes biodiversity loss and climate change as “two sides of the same coin.” Yet solar arrays sometimes consume vast tracts of natural habitat. Hydropower dams can prevent fish from

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swimming and spawning freely. And wind farms have often been accused of threatening birdlife (accusations that are sometimes valid, and sometimes weaponized by those who simply don’t like the look of turbines).

Fryslan is one of a new generation of wind energy projects that asserts it is possible to achieve biodiversity and climate targets in one fell swoop. Its design is a reflection of the words of Dr. Joseph Kiesecker in his 2019 paper in *Frontiers in Environmental Science*, in which he expressed that in building green energy infrastructure, “we should not rob Peter to pay Paul.”

Should birds fear wind farms?

At time of this writing, the NOAA climate observatory at Mauna Loa, Hawaii is registering a carbon dioxide concentration of 420 parts per million in the Earth’s atmosphere. This is higher than at any point in the history of our species, and throws into relief the urgency of transitioning away from fossil fuels if we are to avert the worst impacts of climate change.

Fortunately, our best hopes for doing so — wind and solar energy — continue to decline in cost and are now the least expensive forms of electricity generation. This is good news, because the International Energy Agency estimates that global wind energy capacity needs to more than quadruple by 2050 if we are to halt climate change at relatively safe levels.

But the climate crisis is just one half of our planet’s existential threat. The other is biodiversity loss, which is occurring at up to 1,000 times the average rate observed in the geological record. According to the *Living Planet Report*, populations of vertebrate species have declined on average by 69 percent since the 1970s. And *Birdlife International* reports that 49 percent of the world’s bird species are in decline.

Concerns are often raised about the potential impact of renewables, particularly wind farms, on birds and other wildlife. Indeed, wind farms and power lines can pose a threat to birds through collision and electrocution, habitat loss and disturbance. Failure to address concerns about these impacts, as was the case with the Altamont Pass wind farm in California, which was built in an important area for the North American Golden Eagle population, provides fodder for critics of clean energy who often cite collision risks when objecting to wind energy developments.

But it is important to contextualize these impacts compared to broader causes of bird mortality. A 2016 study estimated that the total number of

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birds killed by wind farms in North America was in the region of 140,000 to 328,000 birds per year. That may sound like a lot, but it pales in comparison with the 16 to 42 million birds per year killed by collisions with buildings. And it is still fewer than the estimated 512,000 birds killed annually by the direct impacts of generating electricity from coal, oil and gas.

Yet sheer numbers are only part of the story. Arguably a more important consideration is understanding the types of birds impacted by wind farms, because this can inform how we best protect those species as we invest in renewable energy. For instance, larger, slower-to-reproduce bird species — like vultures, bustards, grouse, storks, cranes, eagles and certain water birds like swans — are disproportionately affected by collisions with wind turbines and power lines.

Knowing this, we can compensate for their turbine-related losses by, for example, protecting more of their habitats or curbing illegal hunting. Meanwhile, other species can actually benefit from the presence of energy infrastructure. For example, large numbers of white storks in Portugal build their nests in electricity pylons, and in some areas specially designed nesting platforms are added by the energy company, ensuring that this species, though prone to colliding with power lines, can also benefit from the presence of the towers and masts associated with them.

Learning to coexist

Our understanding about how to reduce conflict between birds and wind farms has improved dramatically in recent years, as has collaboration between wind energy companies and conservationists. Today, it's common for the major players in the wind energy industry to work together with scientists, policy makers and communities to find wildlife-friendly solutions.

In their 2016 paper in the journal *Human-Wildlife Interactions*, Dr. Edward Arnett and Dr. Roel May outline a mitigation hierarchy of different measures which can be implemented at wind farm developments designed to “avoid, reduce or mitigate impacts.”

One of the best ways to minimize conflict between birds and renewable energy infrastructure is to produce collision risk maps. Producing these maps at regional, country or continent scale can help developers and planning authorities avoid the most high-risk areas for birds in relation to wind farms and power lines.

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New tools are making this easier. Birdlife International recently launched their AVISTEP online tool which uses the abundance of collision-prone species to map the sensitivity of birds to renewable energy development. Another approach, as outlined in this study in the *Journal of Applied Ecology*, is to use GPS tracking data to map where birds tend to fly at heights where they could collide with wind farms and power lines. The study used data from over 1,400 individual tracked birds to highlight collision risk hotspots where birds would be most sensitive to new wind farm developments and are already vulnerable to the risk posed by existing wind farms and power lines.

Once we understand where these high risk areas are, we can then prioritize where to install measures such as power line markers, which can reduce the risk of collision by approximately 50 percent, or curtailment systems, which can shut down or slow wind turbines when collision-prone species are present in the area. At 20 wind farms around Cadiz in Southern Spain, an important migratory corridor, the implementation of shutdown procedures using radar systems and human observers during peak times reduced the mortality of Griffon Vultures by an average of 92 percent.

Several companies are now seeking to automate monitoring of bird movements at wind farms using AI-powered camera systems to reduce the need for human input. One of these companies is SpoorAI, founded by Ask Helseth, Lorea Coronado-Garcia and Helge Reikerås. The company aims to make wind power more nature-friendly by using computer vision and artificial intelligence to track and identify birds on and around wind farms.

“We use off-the-shelf cameras, which are resistant to both onshore and offshore environmental conditions” explains CEO Helseth. This video stream is processed by SpoorAI's software, then reviewed by humans who identify moving objects, pinpoint birds, identify species and analyze flight trajectories. This allows them to follow, in fine detail, the movements of birds through a wind farm and assess the proportion of flights at heights where the birds could collide with the moving blades. According to Helseth, the system has successfully tracked over 126,000 birds to date in approximately 18,562 monitoring hours.

The SpoorAI system could soon be able to automatically stop turbines from spinning when it detects birds in danger of being struck. “In other words, if we detect that a given species flying within a certain range of a turbine we think is at risk of collision, we can communicate it to the turbine. This feature is increasingly being requested by governments when authorizing new installations.” This development in autonomous

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monitoring and curtailment of wind farms represents a significant step forward in reducing collision risks.

The pace of our transition to clean energy is only set to increase over the coming years. If done poorly, without considering the potential impact on wildlife, ramping up deployment of wind turbines will create conflicts between clean energy and birds. But done well we can meet our renewable energy targets while conserving birds. The good news is that at the 2022 Wind Energy and Wildlife Conference in Ijmuiden in the Netherlands, major players in the wind industry such as Ørsted made it clear that they are keen to be part of the solution.

Reasons to be Cheerful, 21 April 2023

<https://reasonstobecheerful.world>

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Plastic-eating fungi could solve polypropylene pollution problem

2023-04-23

As one of the most commonly used plastics in the world, polypropylene presents a global environmental problem because of issues related to its recycling. Researchers have developed a new way of breaking down this troublesome plastic by enlisting the help of a couple of common fungi.

Most plastics aren't readily degradable and take decades to biodegrade, resulting in the pollution of land and marine ecosystems. One of those plastics, polypropylene (PP), is used in everything from plastic packaging to furnishing and toys. But in terms of plastic waste, PP is over-represented.

Mainly due to its short life span as packaging and the fact that it gets contaminated by other plastics, PP collected at the curbside tends not to be separated out when it reaches recycling facilities, so it ends up in landfill. In 2015, the world produced 75 million tons (68 million tonnes) of PP, of which only 1% was recycled.

But help may be at hand, thanks to a new recycling technique developed by researchers at The University of Sydney with the help of some unassuming fungi.

"Plastic pollution is by far one of the biggest waste issues of our time," said Amira Farzana Samat, lead author of the study. "The vast majority of it isn't adequately recycled, which means it often ends up in our oceans, rivers and in landfill. It's been estimated that 109 million tonnes (120 million tons) have accumulated in the world's rivers and 30 million tonnes (33 million tons) now sit in the world's oceans – with sources estimating this will soon surpass the total mass of fish."

The researchers turned to two fungi commonly found in soil and plants, *Aspergillus terreus* and *Engyodontium album*.

"Fungi are incredibly versatile and known to be able to break down pretty much all substrates," said Dee Carter, co-author of the study. "This superpower is due to their production of powerful enzymes, which are excreted and used to break down substrates into simpler molecules that the fungal cells can then absorb."

The PP was pre-treated with one of either UV light, heat, or Fenton's reagent, an acidic solution of hydrogen peroxide and ferrous iron that's often used to oxidize contaminants.

"Fungi are incredibly versatile and known to be able to break down pretty much all substrates."

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In a Petri dish, the fungi were then applied to the treated PP and the degree of deterioration analyzed using microscopy. The researchers found that the fungi were able to break down PP more effectively when it was pre-treated with UV light or heat. The fungi made relatively fast work of the PP, reducing it by 21% over 30 days and by 25% to 27% over 90 days.

“We need to support the development of disruptive recycling technologies that improve the circularity of plastics, especially those technologies that are driven by biological processes like in our study,” said Ali Abbas, corresponding author of the study. “It is important to note that our study did not yet carry out any optimization of the experimental conditions, so there is plenty of room to further reduce this degradation time.”

Further research will ascertain the biochemical processes underlying this fungi-driven degradation but for now, the researchers plan to enhance the efficiency of their degradation method before seeking investors with a view to commercialization.

The study was published in the journal *NPJ Materials Degradation*.

New Atlas, 23 April 2023

<https://newatlas.com>

Personalized vaccine for melanoma may stave off cancer's return

2023-04-16

A novel cancer vaccine tailored to genetic changes in a person's tumor is showing promise in the clinic. In a study of about 150 people who had surgery for melanoma, a type of skin cancer, those given a personalized vaccine along with an immunotherapy drug were more likely to remain free of cancer 18 months later than patients who did not receive the vaccine.

The results, reported today at the annual meeting of the American Association for Cancer Research (AACR), offer the first clear evidence that a vaccine designed to target mutations within a patient's tumor can prevent its regrowth. That would be a milestone for the cancer vaccine field, which has struggled for decades to show results. It could also add to a growing arsenal of drugs, known as immunotherapies, that harness the immune system to fight cancer. “I was really, really excited to see these data,” says Patrick Ott of the Dana-Farber Cancer Institute, who works on similar

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vaccines. Although small, the new study is “a very exciting first step,” says cancer vaccine researcher Nina Bhardwaj of the Icahn School of Medicine at Mount Sinai.

Cancer vaccines aim to teach the immune system's T cells to attack a tumor by exposing them to a protein, or antigen, that pokes out from a cancer cell. But most vaccines so far haven't worked well because the same antigens found on tumors also appear on normal cells.

In the early 2010s, as DNA sequencing costs dropped, some scientists turned instead to sequencing the mutations in a patient's tumor, then creating a vaccine to deliver a few of the corresponding mutated proteins, known as neoantigens, which are found only on the tumor cells. Several small trials published since 2015 by Ott's team and others have shown that neoantigen vaccines can stimulate vaccine-specific T cells in patients with solid tumors such as melanoma, colon, lung, and brain cancer, and at least in melanoma, may curb cancer growth.

To show this more definitively, Merck and Moderna conducted a randomized trial for patients who had advanced melanoma that had spread to lymph nodes and sometimes other sites, but that had been surgically removed. All got a type of drug, known as a checkpoint inhibitor, that blocks a crucial protein from enabling tumors to evade T cells. Two-thirds also got vaccine infusions every 3 weeks for about 4 months. Like Moderna's COVID-19 vaccine, the cancer vaccine delivered messenger RNA (mRNA) wrapped in lipid nanoparticles into cells, instructing them to make a protein—in this case, up to 34 tumor neoantigens per patient.

In December 2022, the companies made a splash when they reported that patients receiving the vaccine were 44% less likely to die or have a recurrence of their cancer. At the AACR meeting, academic collaborators shared more details: Eighty-four of the 107, or 79%, were still in remission after 18 months, compared with only 31 of 50 (62%) patients who got the checkpoint inhibitor alone. “These data give a very, very encouraging signal,” says Jeffrey Weber of NYU Langone's Perlmutter Cancer Center, the trial's principal investigator.

Also encouraging is that the vaccine worked regardless of how many mutations the person's melanoma tumor had, suggesting it could work for cancer types with fewer mutations. With less to distinguish them from normal cells, such cancers tend to resist immunotherapy drugs. A larger study starting later this year aims to confirm these results and reveal whether the vaccine extends patients' lives, measures that could encourage regulators to approve it. For now, “these [are] intriguing early

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findings," says immunotherapy researcher Suzanne Topalian of Johns Hopkins University. Like other researchers, she hopes to see more details, including evidence that patients who did well made T cells specific to the neoantigens and didn't just get an immune boost from the vaccine's nanoparticles. Weber says those data will be reported in papers the team is submitting to journals.

Other companies are also testing neoantigen vaccines in randomized trials. BioNTech and Genentech expect to report early results this year for a neoantigen mRNA vaccine for metastatic melanoma that can't be surgically removed—a tougher challenge partly because the patients have weakened immune systems. And Gritstone bio is testing a neoantigen mRNA vaccine against metastatic colon cancer; to boost the immune response, it is combined with a modified virus carrying the neoantigens. The Gritstone team reported in *Nature Medicine* in August 2022 that in several cancer patients, this resulted in "very significant numbers of T cells," according to Bhardwaj, a promising sign of efficacy.

One of the most intriguing studies so far tested a BioNTech and Genentech neoantigen vaccine for pancreatic cancer. Investigators reported last summer that eight of 16 patients treated had T cell responses to the vaccine and were still cancer-free up to 2.5 years later. The other eight did not show an immune response and six had relapsed by 18 months. The companies plan to launch a randomized trial of that vaccine for pancreatic cancer this year.

Because pancreatic cancer cells have few mutations, "you might think is the last tumor type" that a neoantigen vaccine would work for, says trial principal investigator Vinod Balachandran of Memorial Sloan Kettering Cancer Center, who will present full details at AACR and in a paper in press. "If you can even do this in pancreatic cancer, this is very encouraging for testing personalized vaccines" for other cancers.

Science, 16 April 2023

<https://science.org>

Animals Are Migrating to the Great Pacific Garbage Patch

2023-04-18

The Great Pacific Garbage Patch does not seem like it would be a hospitable place. It is more than 1,000 miles from the nearest streak of

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land. The sun is brutal and unrelenting there, the waters nutrient poor. There is nothing much to see except the eponymous garbage.

But look more closely at this plastic garbage, as scientists did recently, and you'll find plenty of life: sea anemones as small as a pinky nail or as large as the palm of your hand; white, lacelike bryozoa; hydroids sprouting like orange feathers; shrimplike amphipods; Japanese oysters; mussels. None of these creatures belongs here. They are all coastal animals, adapted to the turbulent, nutrient-rich shores where water meets land, but they have all somehow learned to survive in the open sea, clinging to plastic.

According to a new study, these animals are now living side by side in the Great Pacific Garbage Patch with creatures that normally inhabit the middle of the ocean. Coastal and open-sea ecosystems are blurring together into a single, plastic-bound one. "As humans, we are creating new types of ecosystems that have potentially never been seen before," says Ceridwen Fraser, a biogeographer at the University of Otago, who was not involved in the study. The Garbage Patch, far from being some barren wasteland, is the site of an active experiment in biology.

The scientists behind this study were originally intrigued by debris from the 2011 Japanese tsunami: Even after six years, debris was still washing up in the U.S. laden with creatures native to the Japanese coast. The scientists counted more than 60 species of mollusks alone. If coastal creatures could survive a six-year ocean crossing on plastic, how much longer could they survive? Could they be living on the high seas permanently? Ocean currents tend to trap floating objects in one of five gyres around the world, the most infamous of which is the Great Pacific Garbage Patch, between California and Hawaii. If coastal animals have found a new, plastic-based home anywhere in the open ocean, it would be here.

The "patch" is less a solid island of trash than a soupy swirl of debris ranging from microscopic pieces of plastic to larger objects such as fishing nets and buoys. Getting there is not easy, because it is so far from land. The scientists teamed up with the Ocean Cleanup, a nonprofit that was testing technology for removing trash from the gyre, to collect and freeze 105 pieces of garbage. Linsey Haram, then a postdoctoral fellow at the Smithsonian Environmental Research Center, remembers traveling to a California port in late 2018 to pick up trash bags full of nets, bottles, buoys, flower pots, clothes hangers, and buckets. She and her colleagues found coastal species on 70.5 percent of the debris. "We expected to find some; we just didn't expect to find them at such frequency and diversity," Haram

According to a new study, animals are now living side by side in the Great Pacific Garbage Patch with creatures that normally inhabit the middle of the ocean.

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told me. These migrants were not a minor part of the Great Pacific Garbage Patch ecosystem.

On two-thirds of the objects—essentially tiny floating islands—animals native to coasts were living side by side with animals native to the open ocean. They were smashed together into a single ecosystem and even a single food chain; for example, Haram told me, the coastal sea anemones were eating sea snails. The team also found evidence of the animals reproducing: The anemones were budding off tiny baby anemones, and some of the female crustaceans carried little broods of eggs. This suggests that they have taken up permanent residence and aren't just eking it out temporarily.

Scientists call the ocean surface where water meets sky the “neustonic” or “neustic” habitat. Long before the advent of plastics, this habitat was dominated by natural objects such as kelp, wood, and pumice, on which life could gain a floating toehold. But these were relatively ephemeral. The influx of man-made plastics into the ocean might be “dramatically expanding a long-existing but previously minor habitat,” David Barnes, a marine ecologist with the British Antarctic Survey, told me in an email. It could also change the neustonic habitat in unpredictable ways: Some of the species that once drifted on organic matter, for example, might make the switch to living on plastics better than others. Scientists previously found that a marine insect named *Halobates sericeus* might actually be benefiting from the abundance of material in the Great Pacific Garbage Patch. It once had to lay its eggs on the rare floating feather or pumice stone; now it can just use plastic.

The waters around the plastic in the Garbage Patch are teeming with floating life too: Portuguese man o' wars, blue sea dragons, tiny blue hydrozoans evocatively named by-the-wind sailors. Unlike coastal species that need to hitch a ride on something else, these floating animals likely bobbed here on their own via ocean currents. Little is known about many of them or how the proliferation of tiny plastic islands is affecting them. “We're trying to learn really basic stuff,” says Rebecca Helm, an ecologist at Georgetown University who has cataloged these creatures in the Great Pacific Garbage Patch. Cleaning up the plastic around them is not straightforward: Attempts to collect floating debris, she has written, might entrap and threaten these species.

Many of the Garbage Patch objects that Haram and her collaborators found covered with coastal animals come from the fishing industry: nets, buoys, ropes, crates, eeltrap cones. These items last so long in the ocean,

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she pointed out, precisely because they are engineered to last a long time in seawater. They are part of an industry that has destroyed ocean ecosystems by removing billions of fish and shellfish from their home. Its plastic remnants are now also disrupting old ways of life in the ocean, creating new ways that we never intended and cannot yet imagine.

The Atlantic, 18 April 2023

<https://theatlantic.com>

Microwaving solar panels makes them easier to recycle

2023-04-19

Solar cell manufacturing and recycling should be easier with a surprising new discovery by Macquarie University scientists – that uses a commercial microwave.

While they're being made, the silicon in solar panels goes through a process called “annealing”, which involves heating the materials to temperatures well above 500°C.

Annealing is usually done with ovens. But a study published in *Applied Physics Letters* shows that microwaves are not only faster and more energy efficient for the job, but make the panels much easier to disassemble, and thus recycle, at the end of life.

This is because microwave radiation heats individual substances – like the water in food, or silicon.

“It just heats the very thin layer of silicon rather than heating the bulk of the materials around, and it's really fast,” says lead author Dr Binesh Puthen Veettil, a researcher at Macquarie University's School of Engineering.

This also makes the process easier, because the microwave doesn't have to be as carefully cleaned.

“In most of the high temperature processes, lots of contaminants come out of the walls of the oven. But in this case, the heat is flowing from the silicon outwards, while everything else is at room temperature, it's kind of a pseudo room temperature process where the contaminants don't get diffused from outside,” says Veettil.

“But the thing we are most excited about is the benefit to recycling.”

“You can just peel off the silicon cell, without destroying the glass, and you can reuse that expensive glass.”

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Currently, solar cell recycling is a very energy intense process which involves crushing up the panels and heating them to temperatures of at least 1000°C, so that all of the expensive elements can be extracted.

This method destroys some of the reusable solar cell components: particularly, the toughened glass on the top of the panel.

“This glass contains most of the weight of the solar panel,” explains Veettil.

That glass is stuck to a layer of plastic, usually ethylene vinyl acetate, which keeps the silicon plate underneath dry. This plastic is too hard to remove, so the whole thing is smashed up, with the glass sold as scrap.

But microwaving the silicon specifically softens the plastic, making it easy to peel.

“You can just peel off the silicon cell, without destroying the glass, and you can reuse that expensive glass,” says Veettil.

“If you can reuse the glass, the recycling will pay for itself.”

Plus, it doesn't need the same high temperatures, or extra chemicals needed to wash and dissolve the plastic.

For now, the process is lab-based – and only for solar panels that fit in a commercial microwave.

“Initially, when we started the research, we used a laboratory microwave that we purchased from a US company,” says Veettil.

“And we after that, we purchased some kitchen microwaves locally, and modified it to suit our purposes.”

This modification involved heat-proofing the microwave so that it could handle the annealing temperatures.

“It goes from room temperature to 500° Celsius in just two seconds,” says Veettil. (Depending on the size of the sample: bigger things take longer.)

But the researchers have a patent pending for the recycling process, and are now investigating how to improve and commercialise it.

“We are hoping that with some industry collaboration and funding, we can scale it up,” says Veettil.

“Recycling needs to be meet two conditions: it should be environmentally friendly, and second, it should pay for itself.

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“I'm pretty sure, with the numbers I have in mind, it will it will be profitable and then the market will take care of itself and it organically grow recycling centres. That's my hope.”

Cosmos, 19 April 2023

<https://cosmosmagazine.com>

Lab-grown blood could (one day, maybe) save your life

2023-04-18

Certain parts of the human body, it turns out, are replaceable.

We've engineered artificial hearts that beat, dialysis machines that filter blood, cochlear implants that bypass acoustic hearing, and collagen scaffolds that help generate skin. We've synthesized and administered hormones for gender-affirming therapy, period suppression, birth control, cancer, menopause, and diabetes. We've designed prosthetics to replace not only limbs and digits but also noses, ears, breasts, and genitals. We've swapped out titanium for bones, gold for teeth, glass for eyes.

Across our physiological fabric, however, blood remains an inimitable and fragile thread. This precious, near-magical substance cannot yet be synthesized, manufactured, grown at scale, or stockpiled long term. Today, we have just one way to procure it for transfusion: the goodwill of donors, which often is not nearly enough to meet societal need, resulting in an “uncounted” number of deaths from trauma, postpartum hemorrhage, and childhood anemias.

Blood is essentially its own organ system, said Philip Spinella, surgery and critical care professor at the University of Pittsburgh, co-director of its Trauma and Transfusion Medicine Research Center, and associate medical director of its Center for Military Medicine Research. In humans, it circulates along a 60,000-mile-long vascular freeway, distributing oxygen, cycling nutrients and hormones, removing waste, defending the immune system, distributing heat, and maintaining the body's chemical and fluid balance as it travels. About one-twelfth of an adult body's weight is owed to blood's miracle blend of water, proteins, salts, sugars, fats, oxygen-rich red blood cells, and clot-inducing platelets.

In centuries past, physicians unsuccessfully tried substituting blood with beer, urine, salt water, and milk. But over the last decade, scientists have finally started to make breakthroughs in the medical quest to imitate fresh human blood. Last fall, a groundbreaking UK clinical trial successfully transfused two teaspoons of lab-grown blood into patients, while other

The quixotic, centuries-long search for blood alternatives is finally succeeding.

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approaches are seeking to synthetically recreate blood's various elements and combine them into a functional substitute for the real thing.

These projects remain in early phases, and experts caution that it will be years — potentially a decade — before artificial blood pumps freely through human veins. But in their grandest visions, researchers believe artificial blood could revolutionize how we supply the vital fluid in medical emergencies and, just maybe, even herald a world without blood shortages.

Around the world, blood is in chronically short supply

Every two seconds, someone in the US needs blood. They might need a transfusion for surgery or post-partum hemorrhaging, for cancer therapies, for traumatic injuries from traffic crashes or gunshot wounds, or to treat diseases including sickle cell, malaria, and thalassemia. The leading cause of preventable death from trauma is hemorrhage — uncontrolled blood loss — which kills between 30,000 and 60,000 Americans each year. For those with rare blood types, access to transfusion is inherently harder; finding an exact blood match for them “can be as difficult as looking for a needle in a haystack,” according to the Red Cross. About one in 18 hospitalized patients receive a blood transplant, and demand for donations will only swell as the general population ages, experts say.

During the pandemic, the blood supply shortage reached crisis levels in the US, as fewer people donated and blood donation centers struggled to survive financially. Last year, the American Red Cross announced it was facing its worst shortage in more than a decade and could only meet one-quarter of hospital demand. Overseas around the same time, the United Kingdom's blood stock drained to about two days' worth (they normally aim to stock enough for at least six days).

About 60 percent of the world's nations — including every country in sub-Saharan Africa, South Asia, and Oceania — already chronically struggles to meet the need for blood. Half of blood collected around the world each year comes from the United States, Canada, Europe, and Australia, which altogether account for just one-fifth of the global population. “The consequences of this scarcity are dire,” a global research group noted in 2021.

Disasters regularly sharpen this scarcity's deadline — like this past February's earthquake that killed 50,000 people and injured 122,500 more in Turkey and Syria, or the 160-plus mass shootings that have claimed 225 lives in the US and injured hundreds more so far in 2023. In times of

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emergency or not, “there's a persistent challenge to getting enough,” said Anirban Sen Gupta, a professor of biomedical engineering at Case Western Reserve University in Cleveland and CTO of the biopharma company Haima Therapeutics, which is developing synthetic platelets.

When a hospital's blood stock runs low, canceling elective surgeries serves as a first defense, Li Chai, a transfusion specialist and pathologist at Brigham and Women's Hospital and Harvard Medical School, told me. But sometimes even that may not be enough, forcing physicians to make excruciating decisions to, for example, transfuse cancer patients or preserve precious blood stores for extreme medical emergencies. “It's really hard for me to say, ‘I have nothing for you’” to a patient who needs blood, said Chai.

And so, researchers are striving toward the unprecedented: to outsource the production of blood away from our marrow and into the lab — a project that began in earnest 400-plus years ago.

A brief medical history of blood replacements

With its direct connection to the heart, its vivid hue (from wine-dark to cherry bright and cobalt blue), and its spilling in both birth and death, blood has historically served as a metaphor for humanity, as Susan Lederer, a professor of medical history and bioethics at the University of Wisconsin-Madison, argues in her 2008 book, *Flesh and Blood*. “Write with blood, and thou wilt find that blood is spirit,” wrote Friedrich Nietzsche in the 1880s. “All the soarings of my mind begin in my blood,” wrote Rainer Maria Rilke in 1921. “Blood is memory without language,” added Joyce Carol Oates, more recently.

“People understood it as part of their vital essence,” Lederer told me. “The kidney has much less romance about it.”

Before medicine learned routinely to save lives by sharing blood between bodies in the early 1900s, Lederer writes, healers first spent centuries trying to heal illnesses and disease by draining blood away with lances and leeches. After physician William Harvey described the circulatory system in 1628, Europeans began to consider the possibility of adding liquids like animal blood to the bloodstream. These early pioneers struggled to prove transfusion's safety and efficacy when faced with the physiological reality that blood clots when exposed to air, can transmit disease, and can even prove toxic when mismatched (blood groups were not discovered until 1901). By the end of the 17th century, they largely discarded transfusion

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between humans as a dangerous procedure with little, if any, medical value, Lederer notes.

After a century-plus of dormancy in Europe, North American physicians started up their own transfusion experiments on patients dying of yellow fever and cholera. These efforts were not widespread; during the American Civil War, in which some 750,000 combatants died — and tens of thousands of limbs were amputated on the battlefield — there exist just four records of transfusions, Lederer writes.

The earliest successful transfusions — in the early 20th century — were born of desperation. When no other lifesaving options remained, surgeons infused blood from one patient to another by literally sewing together their exposed blood vessels, which Lederer notes, possessed “the consistency of wet matchsticks.” Over time, advancements such as sterile needles, anticoagulants, and centrifugation made it possible to (almost) painlessly draw blood, refrigerate it for days at a time, and fraction it into its constituent parts: red and white blood cells, plasma, and platelets.

All the while, researchers have continued to look for alternatives to donated fresh blood, which comes with many limitations: It risks disease transmission, can't be stored long term (no more than 42 days), and there's never enough of it. They've experimented for nearly a century with chemically modifying free hemoglobin isolated from red blood cells, but found that these solutions ultimately caused kidney damage and vascular hypertension. Researchers also tried infusing rodents and humans with perfluorochemicals, polymers they hoped would function as red blood cell substitutes, but discovered the transfusions led to fever, inflammation, and low oxygen.

The quest for artificial blood remained unfulfilled.

From lab-grown blood to the “Impossible Burger of blood”

Contemporary researchers — spurred by advances in nanotechnology, bio-inspired engineering, synthetic chemistry, and stem cell research — have developed two distinct strategies for alternatives to fresh blood. They can be analogized to the differing approaches to slaughter-free meat. On one hand, you have the “meatless but meat-like” camp: products made of peas, mung beans, rice, or soy designed to evoke meat without any animal products, like the Beyond or Impossible Burgers. On the other, you have the “cultivated meat” approach, which cultures and grows animal muscle and fat cells in bioreactors, resulting in a meat that is biologically and chemically identical to its farm-raised counterpart.

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The first method — the Impossible Burger of blood — aims to reverse-engineer or repackage whole blood's various components, primarily to make them easier to store at ambient conditions and, later, deliver in the field. To imitate platelets, for example, one research group has engineered nanoparticles — artificial lipid spheres decorated with special peptides — that can facilitate clotting at the site of bleeding once administered through an IV. Others focused on oxygen-rich red blood cells have coated purified human hemoglobin with an artificial lipid membrane to create a bio-synthetic replica with a corpuscle's “natural” size, shape, electric charge, and surface chemistry. Still other groups have tried freeze-drying plasma from a cloudy yellow broth into a powder that can be stored at room temperature for two years.

A new \$46 million Department of Defense DARPA project, FSHARP, aims to combine several of these approaches to produce a lightweight, portable, shelf-stable powder that would become blood-like when mixed with a sterile saline solution. “It's basically ‘just add water,’” said University of Pittsburgh surgeon Spinella, a co-investigator in the project who also is a co-founder of KaloCyte, which is developing an artificial red blood cell, and scientific adviser to the biopharma company Haima Therapeutics. The product would overcome the logistics barriers of delivering fresh blood in remote settings: battlefields, cruise ships, space shuttles, depots for mass casualty events, and geographic regions lacking the infrastructure for adequate donor bloody supply and storage. Researchers hope to move these approaches to human trials within five to eight years.

Scientists trying to grow whole blood in sterile settings, a practice called “blood pharming,” took a major step forward last fall when, for the first time, researchers and collaborators in Bristol, Cambridge, London, and NHS Blood and Transplant transfused a few teaspoons of lab-grown blood into two experimental subjects with no reported adverse effects.

To grow the blood, researchers use magnetic beads to extract viable stem cells from standard blood donations. They then cultivate around half a million stem cells in 5 millimeters of a nutrient-rich medium into billions of red blood cells over about three weeks, before filtering and testing the resulting substance for safety. Eventually, the trial will include a total of 10 human subjects, who will each receive, six months apart, transfusions of donated blood and lab-made blood grown from that same human donor's cells. Researchers will carefully monitor how long each blood type — donated and lab-grown — stays in the body, and what kind of antibodies, if any, they elicit from the immune system.

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In the boldest fantasies, both pharmed and artificial sanguine substances could go so far as to not only imitate, but augment, donor blood's utility.

For example, lab-grown methods could eventually make extra blood from rare-type donations and even genetically modify them to deliver enzymes or therapeutics to people with blood disorders, said Ash Toye, a professor of cell biology at the University of Bristol involved in the lab-grown blood trial. "My vision is a warehouse full of machines making blood," he said.

Scientists working on the Defense Department project told Vox that powdered blood's clotting and oxygen-delivery capabilities could be adjusted based on the patient's unique biology and medical need. "There's a lot of bespoke custom uses," said Allan Doctor, the project's lead investigator, a pediatrics and bioengineering professor at the University of Maryland and director of the school's Center for Blood Oxygen Transport and Hemostasis, and a co-founder of KaloCyte. Just as oncologists tailor a patient's chemotherapy to their cancer's specific genetics, artificial blood specialists could create blends ideal for post-partum hemorrhaging, pre-surgical preparations, or transplant organ perfusion. "That's the level of precision medicine we need to achieve in transfusion," said Matthew Neal, a trauma surgeon, director of emergency general surgery at the University of Pittsburgh Medical Center, co-director of its Trauma and Transfusion Medicine Research Center, DARPA investigator, and Haima Therapeutics' chief medical officer.

But like their predecessors, today's researchers are struggling to outperform the practicality and performance of natural blood.

Blood pharming, for example, faces efficiency, resource, and time constraints. For one, there's a limit to how much blood the recruited stem cells can make outside of bone marrow's niche environment. "The system can only expand so far. There's a limitation to how much you can grow," Toye said. "Eventually you exhaust those stem cells." Expense poses a hurdle too. It costs between \$80 and \$100 to collect, store, test, and handle donor blood; lab-grown blood, experts say, can run thousands of dollars per unit to produce.

The powdered blood approach, meanwhile, needs to braid together separate scientific efforts to replicate or artificially preserve red blood cells, plasma, and platelets. There's practically no chance that it all works in symphony right away, Doctor said. "The likelihood that we happened to make it in a way that it will work harmoniously is zero," he said. "It's like saying, 'I made the best key and you made the best lock.' What are the chances they're going to fit together?"

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It'll be a while before any artificial blood products are made available to the public, as they have yet to prove their efficacy and safety through rigorous animal and clinical trials. But these projects also open up a plethora of ethical, social, and legal questions, said Shannon E. French, a Case Western ethicist tasked with monitoring and exploring these implications.

Will the final version of an artificial blood contain any animal products that some religions or philosophies don't condone consuming? Will it help equalize access to blood, or will it remain a revolutionary product that only the richest nations have access to? Could it even, given the Defense Department's interest in the project, create a moral hazard that encourages the military to send troops further into remote or hostile areas, knowing that blood would be readily available to treat the injured? Even if the science is all there, the way that it shapes society is unforeseeable. "It might not do the good that it's meant to do," French said.

For now, synthetic blood researchers have to confront the inescapable fact that their alternative has to be, at a minimum, as good as the real thing. And that'll be a high bar to clear, Sen Gupta said. "Mimicking nature is not easy."

Vox, 18 April 2023

<https://vox.com>

Why You Should Eat More Live Microorganisms

2023-04-19

A recent study reveals that individuals who consume higher amounts of live microorganisms on a daily basis tend to have lower weight and improved overall health.

Live microorganisms that are safe to consume can be found in many of the foods we eat daily, including fermented foods like yogurt and raw fruits and vegetables. Despite the common perception that these blends of live bacteria promote good health, there has been a shortage of concrete evidence supporting the link between live dietary microorganisms and improved health.

A recent study has presented some of the first real-world evidence that consuming more live microorganisms can have a positive impact on health. Researchers from the International Scientific Association for Probiotics and Prebiotics (ISAPP) led the study and used the US National Health and Nutrition Examination Survey (NHANES) to categorize

Foods with live microorganisms include yogurt and other fermented foods, as well as raw fruits and vegetables.

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over 9,000 foods into three groups based on the concentration of live microbes they contain. By analyzing the reported food intake of NHANES participants, the scientists were able to quantify the amount of food consumed that had moderate to high levels of live microbes.

Then they determined how these intakes correlated with various markers of health such as blood pressure and weight.

The scientists found that increased consumption of live microbes in the diet was linked with multiple measurements of better health: more favorable blood pressure, better blood glucose, and insulin, lower inflammation, as well as lower waist circumference and body mass index. This established that those who consumed higher quantities of live dietary microbes showed tangible, if modest, health benefits.

While the scientific approach did not allow researchers to conclude that the live dietary microorganisms directly caused the health benefits, the results are consistent with plausible arguments that dietary exposure to live microorganisms, in general, could benefit health by increasing the diversity of microbes in the gut or by supporting immune function. In the past century, a reduction in the amount of fermented foods in the diet and increased consumption of processed foods have led to a dramatic reduction in the number of microbes most people consume on a daily basis.

This trend may be reversing, however, since the dietary data used in the study showed that US adults have gradually increased their live microbe consumption over the 18-year study period. This may bode well for the health of the population.

This study was built on two previously published papers, here and here, which conducted the preliminary work necessary to make this assessment of live dietary microbes and health.

"Although the dose-response associations we found were relatively modest, it was notable that these estimated benefits applied to several plausible and important health outcomes and were robust to adjustment for available confounders, including body mass index," says co-lead author Prof. Dan Tancredi, Ph.D., of the University of California – Davis. "More research that extends these findings to other populations and research that uses study designs that permit stronger causal claims is needed, especially given the potential benefits that might be available by simply substituting into the diet more foods that have safe live microbes."

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ISAPP Executive Science Officer Mary Ellen Sanders, Ph.D., points out the research focused not just on probiotics, but on all microbes in foods, including environmental microbes associated with raw fruits and vegetables as well as lactic acid bacteria associated with fermented foods. Thus, the study differs from probiotic research, which focuses on microbes defined to the strain level, specific dose, and proven health benefits.

Co-first author Prof. Colin Hill, Ph.D., of University College Cork, Ireland, says it's possible that dietary advice of the future could include a recommendation for the daily consumption of high levels of live dietary microbes.

"Those foods with high levels of microbes (fermented foods, raw vegetables, and fruits) are all nutritionally valuable parts of a healthy and diverse diet," he says. "Secondly, these same foods could be providing an additional, hitherto unrecognized, health benefit due to live microbes themselves that enter the gut and interact with the host microbiome, immune system, and even the enteric nervous system".

Sci Tech Daily, 19 April 2023

<https://scitechdaily.com>

Toxic leaves may be reason Lumholtz's tree kangaroos are losing their eyesight, researcher believes

2023-04-23

Rare, rainforest-dwelling mammals have been turning up in hardware stores, service stations and school classrooms in the Atherton Tablelands.

The Lumholtz's tree kangaroos appear to be lost, dazed and blind, but scientists are baffled as to why.

It seems more than one species of kangaroo has been afflicted by blindness, with evidence of eastern grey kangaroos as well as the Lumholtz's tree kangaroos experiencing vision impairment.

Veterinary experts would like to see more funding provided to look into the reasons why.

Lumholtz's tree kangaroos are one of just two tree kangaroo species in Australia, found only in Far North Queensland between Cardwell and the Daintree.

They have been observed to be suffering from blindness for 10 years.

Some eastern grey kangaroos have also been experiencing blindness and research suggests it was caused by toxic grass.

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Karen Coombes, who has a PhD in Lumholtz's tree kangaroos and founded the Tree Roo Rescue and Conservation Centre in Malanda, west of Cairns, said 18 out of 20 tree kangaroos in her care had vision impairment.

"We don't say they are blind because they can see a little bit, but it's their focus and depth perception that is decreasing for some reason," she said.

Dr Coombes said the tree kangaroos had been found in some "really crazy places" such as a hardware store, service stations and school classrooms.

"This is not normal behaviour for a tree kangaroo," she said.

"They are turning up lost and miles away from the rainforest."

Specialist veterinary ophthalmologist Tony Read, who treats eye disorders in animals, has been examining the tree kangaroos in Dr Coombes's care for the past 10 years and has concluded the actual eyes appear fine — but the animals' behaviour suggests otherwise.

"The eyes look normal on examination, meaning there are no structural abnormalities like cataracts or retinal changes, but we are concerned about central blindness," he said.

"They seem to have light sensation which we call the dazzle effect, where the optic nerve still has a reaction to light but it doesn't mean they have full vision."

Dr Read said the tree kangaroos were also showing behavioural vision problems, behaving as though they were blind and acting confused and dazed when rescued.

Dr Coombes has been sending samples to Andrew Peters, a veterinary pathologist and associate professor in wildlife health and pathology at Charles Sturt University, in NSW, for several years and he has confirmed the animals are sight-impaired.

"The clinical assessment is that the animals had central blindness and we found pretty subtle, mild inflammation in the optic nerves," he said.

"The conclusion was optic nerve and brain damage which unfortunately is irreversible."

How common is blindness in kangaroos?

This is not the first time the issue of blindness in some kangaroo species has caused concern.

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Dr Peters said a student at Charles Sturt University investigated blindness in eastern grey kangaroos in Wagga Wagga years ago.

He said her findings showed the blindness was caused by an introduced exotic grass.

"It was the first time toxic plants were linked with blindness in Australian wildlife," he said.

"What was interesting is it was linked with the particular climate at the time, rainfall after a prolonged dry period, all leading to the invasive grass taking over pastures."

Dr Coombes believes climate also may be behind increased toxicity in the leaves the Lumholtz's tree kangaroos are eating.

"I believe the rainforest is facing stress from lack of rain and hotter temperatures and with less water in the leaves, the toxins are more concentrated," she said.

"The roos rely on the leaves for water and when they eat them, the neurotoxins are making their immune system compromised."

Dr Peters said it was difficult to conclusively say if toxic leaves or a virus were causing vision impairment, because the effects of toxic plants could also masquerade as other kinds of diseases such as viruses.

"Toxic plants and viruses can both be associated with habitat change, climatic change and invasive species that can lead to diseases appearing in wildlife that weren't there before," he said.

Dr Peters said there had been many cases where viruses caused blindness in kangaroos and all were mosquito-borne, but to test if a virus had come from mosquitoes, there needed to be large sample numbers to study.

Dr Coombes said whatever was causing the vision impairment did not appear to be genetic.

"The babies born to sight-impaired adults can see and don't show any signs of blindness," she said.

Joeys rescued from a dead mother's pouch stay at the Tree Roo Rescue and Conservation Centre until they are at least two and a half years old, as this is how long they would stay with their mothers.

They are then released back into the rainforest to live healthy lives.

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Tree kangaroos that are vision-impaired and cannot be released are cared for by Dr Coombes and her volunteers, until they have been cleared to go to a zoo as part of a captive management and breeding program.

“These animals get to live out the rest of their lives in massive enclosures,” she said.

“In turn they also educate people about the issues affecting tree kangaroos and become part of the breeding program.

“You can’t save a species unless people know about them and a lot of Australians don’t even know that tree kangaroos exist.”

ABC News, 23 April 2023

<https://abc.net.au>

Do ‘stuck’ stem cells make hair turn gray?

2023-04-20

The research focused on cells in the skin of mice that are also found in humans called melanocyte stem cells, or McSCs. Hair color is controlled by whether nonfunctional but continually multiplying pools of McSCs within hair follicles get the signal to become mature cells that make the protein pigments responsible for color.

The study in Nature shows that McSCs are remarkably plastic. This means that during normal hair growth, such cells continually move back and forth on the maturity axis as they transit between compartments of the developing hair follicle. It is inside these compartments where McSCs are exposed to different levels of maturity-influencing protein signals.

Specifically, the researchers found that McSCs transform between their most primitive stem cell state and the next stage of their maturation, the transit-amplifying state, and depending on their location.

The researchers found that as hair ages, sheds, and then repeatedly grows back, increasing numbers of McSCs get stuck in the stem cell compartment called the hair follicle bulge. There, they remain, do not mature into the transit-amplifying state, and do not travel back to their original location in the germ compartment, where WNT proteins would have prodded them to regenerate into pigment cells.

“Our study adds to our basic understanding of how melanocyte stem cells work to color hair,” says lead investigator Qi Sun, a postdoctoral fellow at New York University Langone Health.

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“The newfound mechanisms raise the possibility that the same fixed positioning of melanocyte stem cells may exist in humans. If so, it presents a potential pathway for reversing or preventing the graying of human hair by helping jammed cells to move again between developing hair follicle compartments.”

The researchers say McSC plasticity is not present in other self-regenerating stem cells, such as those making up the hair follicle itself, which are known to move in only one direction along an established timeline as they mature. For example, transit-amplifying hair follicle cells never revert to their original stem cell state. This helps explain in part why hair can keep growing even while its pigmentation fails, Sun says.

Earlier work by the same research team showed that WNT signaling was needed to stimulate the McSCs to mature and produce pigment. That study had also shown that McSCs were many trillions of times less exposed to WNT signaling in the hair follicle bulge than in the hair germ compartment, which is situated directly below the bulge.

In the latest experiments in mice whose hair was physically aged by plucking and forced regrowth, the number of hair follicles with McSCs lodged in the follicle bulge increased from 15% before plucking to nearly half after forced aging. These cells remained incapable of regenerating or maturing into pigment-producing melanocytes.

The researchers found the stuck McSCs ceased their regenerative behavior as they were no longer exposed to much WNT signaling and hence their ability to produce pigment in new hair follicles, which continued to grow.

By contrast, other McSCs that continued to move back and forth between the follicle bulge and hair germ retained their ability to regenerate as McSCs, mature into melanocytes, and produce pigment over the entire study period of two years.

“It is the loss of chameleon-like function in melanocyte stem cells that may be responsible for graying and loss of hair color,” says study senior investigator Mayumi Ito, a professor in the dermatology department and cell biology department.

“These findings suggest that melanocyte stem cell motility and reversible differentiation are key to keeping hair healthy and colored,” Ito says.

The team has plans to investigate means of restoring motility of McSCs or of physically moving them back to their germ compartment, where they can produce pigment, Ito says.

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For the study, researchers used recent 3D-intravital-imaging and scRNA-seq techniques to track cells in almost real time as they aged and moved within each hair follicle.

Additional coauthors are from Kyoto University in Japan, the Icahn School of Medicine at Mount Sinai, and NYU Langone.

The National Institutes of Health and the Department of Defense supported the work.

Futurity, 20 April 2023

<https://futura.org>

Your smartwatch could detect early parkinson's signs

2023-04-20

These technologies could provide researchers with more objective and continuous ways to measure the disease and bring new treatments to market faster, particularly for patients in the early stages of the disease.

"This research shows that readily accessible and ubiquitous technology has the potential to detect and objectively measure severity and potentially progression of important symptoms of Parkinson's disease," says Jamie Adams, a neurologist at the University of Rochester Medical Center, and first author of the study in *npj Parkinson's Disease*.

While Parkinson's is the world's fastest growing brain disease, most of the drugs used to treat it were developed in the last century. The complexity of the disease and limitation of current measures have been barriers to new therapies.

Onset and severity of symptoms—such as stiffness in the arms and legs, movement and walking difficulty, and tremors—and progression of the disease can vary significantly from patient to patient.

Furthermore, the tools traditionally used to track the disease are subjective and episodic, e.g. only collected during visits to the clinic, limiting insight into how Parkinson's disease affects people's daily lives.

In 2015, URM neurologist Ray Dorsey and the URM Center for Health + Technology (CHeT) team collaborated with Sage Bionetworks to launch the first smartphone research application to monitor Parkinson's disease in real time.

Commercially available smartwatches and phones can capture key features of early, untreated Parkinson's disease, according to a new study.

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Apple featured the app, called mPower, during their semi-annual product launch event, and 15,000 individuals participated in research using the application. Studies have shown that mPower and another Android app can accurately track the severity of the symptoms of Parkinson's disease. Dorsey is senior author of the new smartwatch study.

Since the launch of mPower, the proliferation of smartwatches and technological improvements, particularly in gyroscopes and accelerometers that can more precisely measure movement, has heightened the research potential of these devices.

In the new WATCH-PD study, researchers at multiple sites across the United States recruited 82 individuals with early, untreated Parkinson's and 50 age-matched controls and followed them for 12 months.

The study volunteers wore research-grade sensors, an Apple Watch, and an iPhone while performing standardized assessments in clinic. At home, participants wore the smartwatch for seven days after each clinic visit and completed motor, speech, and cognitive tasks on the smartphone every other week.

The smartphone app tracked finger-tapping speed, performance on cognitive tasks, and speech, while the smartwatch was able to measure arm movement, duration of tremors, and gait features.

The researchers were able to detect motor and non-motor features that differed between individuals with early Parkinson's and age-matched controls. The team performing longitudinal analysis and also conducting a study that will follow participants for a longer period to determine which digital measures are sensitive enough to help researchers evaluate whether an experimental therapy is making a meaningful impact on the progression of the disease.

"These findings reinforce what other studies have shown—digital devices can differentiate between people with and without early Parkinson's and are more sensitive than traditional rating scales for some measures of Parkinson's disease," says Adams.

For example, the researchers note that the smartphone app detected abnormalities in speech rated "normal" by investigators. "Better measures will lead to more efficient, patient-centric, and timely evaluation of therapies."

Additional coauthors are from Harvard Medical School, the Bill and Melinda Gates Foundation, Takeda Pharmaceuticals, Invariant Research

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Limited, AbbVie Pharmaceuticals, Clinical Ink, and the University of Rochester Medical School.

Biogen, Takeda, and members of the Critical Path for Parkinson's Consortium 3DT Initiative funded the work.

Futurity, 2023-04-20

<https://futura.org>

How can Fuel Cell micro-CHP help us to decarbonize buildings?

2023-04-24

Experience gained during the EU-funded PACE project shows that fuel cell micro-cogeneration (also known as fuel cell micro-CHP) could play a positive role in reducing emissions and enabling the uptake of renewables, whilst empowering consumers and providing households and businesses with electricity and heat in a way that is efficient, reliable and affordable.

Between 2016 and 2023, the PACE project has deployed and monitored more than 2500 fuel cell micro-CHP systems in buildings across 10 European countries. Results from the trial confirm that this technology is highly reliable, efficient and convenient. Moreover, data analysis, confirmed by customer feedback, shows that overall energy costs for buildings with fuel cell micro-CHP systems are significantly lower than those of other buildings.

Fuel cell micro-CHP is a proven, highly efficient and reliable energy solution that can be installed in buildings of various sizes and uses. It empowers households and businesses (especially SMEs) by enabling them to meet their own electricity and heat needs. At the heart of the system is a fuel cell, which generates electricity and heat by combining hydrogen with oxygen in a clean process that minimises local air pollution. Indeed, fuel cells have been designated as a 'strategic net-zero technology' by the European Commission.

Europe has a strong manufacturing base for fuel cell micro-CHP, thanks to more than €200 million of private investments by EU industry. This manufacturing capacity was significantly expanded during the lifetime of the PACE project, which has also provided more than 3400 technicians with training in installation and maintenance.

The results of the PACE project confirm the benefits of fuel cell micro-CHP technology:

Europe has a strong manufacturing base for fuel cell micro-CHP, thanks to more than €200 million of private investments by EU industry.

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Boosts efficiency: with an overall system efficiency of up to 95% and electrical efficiencies between 35%-60%, Fuel Cell micro-CHP can deliver significant energy savings and CO2 emission reductions compared to other technologies.

Minimises air pollution: a fuel cell can generate electricity and heat without burning any fuel. The environmental impact is therefore minimised, with zero emissions of smoke, particles (soot) or chemical pollutants such as sulphur oxides (SOx) and nitrogen oxides (NOx).

Reduces CO2 emissions: fuel cells can deliver significantly lower carbon dioxide thanks to their superior efficiency. When replacing a stand-alone gas boiler, a fuel cell micro-CHP can reduce a building's overall emissions (including both on-site and off-site emissions) by up to 50%.

Enables the energy transition: as biomethane and hydrogen become more widely available and cost-effective, fuel cell micro-CHP will ensure the most efficient use of these renewable gases, whilst also complementing the wider deployment of wind turbines and solar panels.

Enhances system resilience: in the context of an increasingly decentralized energy system, fuel cell micro-CHP complements intermittent renewables such as wind and solar (PV) and provides a reliable supply of locally produced electricity that can support the deployment of heat pumps and electric vehicles.

Empowers consumers: Fuel cell micro-CHP transforms Europeans into active energy 'prosumers' (producer-consumers), contributing to a decentralised energy system with a reduced carbon footprint and lower energy bills. An analysis of energy bills in 3 different EU countries found cost savings for consumers in the range between 30% and 80%.

Supports skilled jobs: The development, design and manufacture of Fuel Cell micro-CHP systems and their components provides an important source of high-quality jobs and contributes to Europe's economic prosperity. The deployment of this technology also supports jobs across the whole supply chain, including installation and maintenance.

As Europe makes progress along the road towards a more decentralised and carbon-neutral energy system, policymakers and the broader energy community must fully acknowledge the positive role that fuel cells can play. Specifically, fuel cell micro-CHP can ensure that renewable gases like biomethane and clean hydrogen are used in the most efficient way, delivering electricity and heat where it is required. They can support the

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deployment of clean technologies like heat pumps and electric vehicles, whilst complementing intermittent renewables such as solar (PV) and wind.

The PACE project has brought together a number of leading European manufacturers (BDR Thermea Group, BOSCH, SolydEra, Sunfire & Viessmann) alongside researchers from the Technical University of Denmark (DTU), Element Energy and the Institute for Innovation and Technology Management at HSLU in Switzerland. The project has been coordinated by COGEN Europe and co-funded by the EU's Clean Hydrogen Partnership.

Euractiv, 24 April 2023

<https://euractiv.com>

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Technical Notes

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

CHEMICAL EFFECTS

[Simultaneous determination and dietary intake risk assessment of 60 herbicide residues in aquatic products](#)

[The association between multi-heavy metals exposure and lung function in a typical rural population of Northwest China](#)

[Cardiotoxicity of chloroquine and hydroxychloroquine through mitochondrial pathway](#)

ENVIRONMENTAL RESEARCH

[Intermediate and long-term exposure to air pollution and temperature and the extracellular microRNA profile of participants in the normative aging study \(NAS\)](#)

[An algorithm for quantitatively estimating occupational endotoxin exposure in the Biomarkers of Exposure and Effect in Agriculture \(BEEA\) study: I. Development of task-specific exposure levels from published data](#)

PHARMACEUTICAL/TOXICOLOGY

[Aluminum induces a stress response in zebrafish gills by influencing metabolic parameters, morphology, and redox homeostasis](#)

[Different biological effects of exposure to far-UVC \(222 nm\) and near-UVC \(254 nm\) irradiation](#)

OCCUPATIONAL

[Focusing on testosterone levels in male: A half-longitudinal study of polycyclic aromatic hydrocarbon exposure and diastolic blood pressure in coke oven workers](#)

[Occupational exposures in the rubber tire industry and risk of cancer: a systematic review](#)

[Human occupational exposure to microplastics: A cross-sectional study in a plastic products manufacturing plant](#)