CHEMWATCH

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ASIA PACIFIC

FSANZ Approvals

2023-02-21

FSANZ has approved variations arising from the following applications and proposals:

- Application A1219 – Alpha-amylase from GM Bacillus licheniformis as a processing aid
- Application A1249 – Addition of phytosterols, phytostanols or their esters as a novel food to plant-based milk alternatives.

Read More

FSANZ, 21-02-23

https://www.foodstandards.gov.au/

FSANZ New applications and proposals

2023-02-21

Application A1263 – Rhodomonas salina biomass and extract as a novel food

To permit Rhodomonas salina biomass and extract as a novel food.

Application A1265 – 2'-FL DFL, LNT, 6'-SL sodium salt and 3'-SL sodium salt for use as nutritive substances in infant formula products

To permit the voluntary use of four human-identical milk oligosaccharide (HiMO) ingredients produced by microbial fermentation, alone or in combinations, as nutritive substances in infant formula products.

Application A1267 – Fructanase from GM Trichoderma reesei as a processing aid

To permit fructanase from genetically modified Trichoderma reesei to be used as a processing aid in bakery products.

Read More

FSANZ, 21-02-23

https://www.foodstandards.gov.au/

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The reassessments work plan

2023-03-06

The reassessment work plan shows which substances we will reassess next, with an indicative start date.

Each substance was screened and through its evaluation placed on the reassessments work plan.

Updates

Reassessments work plan last major update: 16 February 2023

Next planned major update: December 2023

Please note – unplanned minor updates may be made at any time to update information or remove completed reassessments, but substances will only be added during major updates.

Detailed information about the substances

More information about each reassessment, such as the reasons for the reassessment and the approvals that may be affected, is included at the bottom of this page.

Read More

EPA New Zealand, 06-03-23

https://www.epa.govt.nz/industry-areas/hazardous-substances/chemical-reassessment-programme/the-reassessments-work-plan/

Updates to the Cosmetic Products Group Standard

2023-03-06

We're seeking feedback by 31 May 2023 on proposed updates to the Cosmetic Products Group Standard, which contains rules for cosmetics in Aotearoa New Zealand.

Cosmetics are hugely popular, and many products sold in Aotearoa New Zealand are regulated as cosmetics. They include things you may not think of as cosmetics, such as soap, shampoo, and sunscreen. The group standard contains rules for these products, including how they must be labelled and what ingredients are banned or restricted.

The updates we propose

Here's a summary of the main proposed updates.

Aligning our rules for ingredients with the European Union

Schedules 4 to 8 of the group standard are lists of ingredients that are banned, restricted, or subject to other rules. The main aim of the updates is to align these lists with the requirements of the European Union – seen as a global high standard.

Phasing out PFAS ingredients

Sometimes called forever chemicals, perfluoroalkyl and polyfluoroalkyl substances (PFAS) are used as ingredients in some cosmetics. We're proposing to ban these ingredients from cosmetics, phasing them out by the end of 2025.

Extending the group standard to cover more products

Some cosmetic products currently contain hazardous substances in concentrations too small to classify the overall product as hazardous. We're proposing to require these products to comply with the group standard. This change aims to protect consumers, give the industry clearer rules to follow, and support enforcement.

We also propose several other updates, including:

- requiring clear recordkeeping for nanomaterials
- updating requirements for fragrances
- consolidating the main text and Schedules 4 to 8 into one document
- improving the presentation and useability of the group standard.

Read More

EPA New Zealand, 06-03-23

https://www.epa.govt.nz/public-consultations/open-consultations/updates-to-the-cosmetic-products-group-standard/

AMERICA

EPA Revises Definition Of "Waters Of The United States"

2023-03-06

On January 18, 2023, EPA and the Department of the Army published a final rule that defines the scope of waters protected under the Clean Water Act (CWA). 88 Fed. Reg. 3004. In developing this rule, the agencies considered the text of the relevant CWA provisions and the statute as a

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whole, the scientific record, relevant Supreme Court case law, and the agencies' experience and technical expertise after more than 45 years of implementing the longstanding pre-2015 regulations defining "waters of the United States" (WOTUS). In the final rule, the agencies interpret WOTUS to include:

- Traditional navigable waters, the territorial seas, and interstate waters ("paragraph (a)(1) waters");
- Impoundments of WOTUS ("paragraph (a)(2) impoundments");
- Tributaries to traditional navigable waters, the territorial seas, interstate waters, or paragraph (a)(2) impoundments when the tributaries meet either the relatively permanent standard or the significant nexus standard ("jurisdictional tributaries");
- Wetlands adjacent to paragraph (a)(1) waters, wetlands adjacent to and with a continuous surface connection to relatively permanent paragraph (a)(2) impoundments, wetlands adjacent to tributaries that meet the relatively permanent standard, and wetlands adjacent to paragraph (a)(2) impoundments or jurisdictional tributaries when the wetlands meet the significant nexus standard ("jurisdictional adjacent wetlands"); and
- Intrastate lakes and ponds, streams, or wetlands not identified in paragraphs (a)(1) through (4) that meet either the relatively permanent standard or the significant nexus standard ("paragraph (a)(5) waters").

The final rule is effective on March 20, 2023.

Read More

JDSupra, 06-03-23

https://www.jdsupra.com/legalnews/wrap-up-of-federal-and-state-chemical-2408877/

EPA Publishes Final Heavy-Duty Engine And Vehicle Standards

2023-03-06

On January 24, 2023, EPA published a final rule intended to reduce air pollution further, including ozone and particulate matter (PM), from heavy-duty engines and vehicles across the United States. 88 Fed. Reg. 4296. According to EPA, the final program includes new emission standards "that are significantly more stringent and that cover a wider range of heavy-duty engine operating conditions compared to today's

standards; further, the final program requires these more stringent emissions standards to be met for a longer period of when these engines operate on the road." The final rule promulgates new numeric standards and changes key provisions of the existing heavy-duty emission control program, including the test procedures, regulatory useful life, emission-related warranty, and other requirements. EPA also made limited amendments to the regulations that implement its air pollutant emission standards for other sectors (e.g., light-duty vehicles, marine diesel engines, locomotives, and various other types of nonroad engines, vehicles, and equipment).

The final rule is effective on March 27, 2023.

Read More

JDSupra, 06-03-23

https://www.jdsupra.com/legalnews/wrap-up-of-federal-and-state-chemical-2408877/

Congressional Democrats Urge EPA To Strengthen Proposed RMP Rule To Protect Americans From Chemical Accidents

2023-06-03

On January 27, 2023, Senator Tom Carper (D-DE), Chair of the Senate Committee on Environment and Public Works, and Representative Lisa Blunt Rochester (D-DE), as well as 47 other congressional colleagues, sent a letter to EPA Administrator Michael S. Regan urging the Agency to strengthen protections for workers, environmental justice communities, and first responders under its August 2022 proposed Risk Management Program (RMP) rule. According to the letter, the final RMP rule "should prioritize hazard reduction and prevention measures, including transitioning to inherently safer chemicals and processes and requiring third-party audits to verify compliance." To ensure adequate protection for those living near RMP facilities, the final rule should improve requirements for outreach to inform the public about RMP facility hazards and emergency response plans before and during incidental releases and require that this information be made available in multiple languages. To foster information access and transparency, EPA should maintain a publicly accessible RMP database and commit to delivering that database on the fastest possible timeline.

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JDSupra, 06-03-23

https://www.jdsupra.com/legalnews/wrap-up-of-federal-and-state-chemical-2408877/

EPA Excludes HFO-1336mzz(E) From Regulatory Definition Of VOC

2023-03-06

On February 8, 2023, EPA published a final rule that revises EPA's regulatory definition of volatile organic compounds (VOC) to exempt trans-1,1,1,4,4,4-hexafluorobut-2-ene (HFO-1336mzz(E)). 88 Fed. Reg. 8226. The final action adds HFO-1336mzz(E) to the list of compounds excluded from the regulatory definition of VOC on the basis that this compound makes a negligible contribution to tropospheric ozone (O3) formation. The final rule will be effective on April 10, 2023.

Read More

JDSupra, 06-03-23

https://www.jdsupra.com/legalnews/wrap-up-of-federal-and-state-chemical-2408877/

Biden Administration Announces $2 Billion In Bipartisan Infrastructure Law Funding To States And Territories To Address Emerging Contaminants Like PFAS In Drinking Water

2023-03-06

On February 13, 2023, EPA announced the availability of $2 billion from President Biden's Bipartisan Infrastructure Law to address emerging contaminants like PFAS in drinking water across the country. According to EPA, this investment, which is allocated to states and territories, will be made available to communities as grants through EPA's Emerging Contaminants in Small or Disadvantaged Communities (EC-SDC) Grant Program and is intended to promote access to safe and clean water in small, rural, and disadvantaged communities while supporting local economies. EPA also released the Emerging Contaminants in Small or Disadvantaged Communities Grant Implementation document. The implementation document provides states and communities with the information necessary to use this funding to address local water quality

and public health challenges. These grants will enable communities to improve local water infrastructure and reduce emerging contaminants in drinking water by implementing solutions such as installing necessary treatment solutions.

Read More

JDSupra, 06-03-23

https://www.jdsupra.com/legalnews/wrap-up-of-federal-and-state-chemical-2408877/

EPA Publishes Draft Inventory Of U.S. GHG Emissions And Sinks

2023-03-06

EPA announced on February 15, 2023, that the Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021 is available for public review. 88 Fed. Reg. 9881. EPA requests recommendations for improving the overall quality of the inventory report to be prepared in final in April 2023, as well as subsequent inventory reports. Comments are due March 17, 2023. EPA notes that it will consider comments received after that date for the next edition.

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JDSupra, 06-03-23

https://www.jdsupra.com/legalnews/wrap-up-of-federal-and-state-chemical-2408877/

EUROPE

EU Court of Justice rules in favor of ECHA identifying BPAs as SVHC

2023-03-16

Trade body PlasticsEurope loses fourth legal case concerning regulations of bisphenol A (BPA); European Court of Justice supports ECHA's classification of BPA as substance of high very high concern (SVHC)

In a ruling from March 9, 2023, the European Court of Justice decided that the European Chemicals Agency's (ECHA's) identification of bisphenol A (BPA; CAS 80-05-07) as a substance of very high concern (SVHC) due to

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having endocrine disrupting properties for the environment was justified. The ruling follows an appeal put forward by PlasticsEurope on March 1, 2021, to an earlier EU court decision confirming BPA as an SVHC. Thus, the trade body gets another appeal case regarding BPA's endocrine-disrupting effects on the environment dismissed.

The EU General Court came to the same conclusion in a court ruling from December 16, 2020. This is the fourth case PlasticsEurope has lost in the European courts over the regulatory status of BPA (FPF reported, also here and here). This marks the end of a series of legal challenges for the trade association over the identification of BPA, according to a Chemical Watch report from March 9, 2023. Looking ahead, there is an ongoing public consultation for a proposed EU-wide restriction on bisphenols under REACH. The consultation is open for comments until June 22, 2023 (FPF reported).

Read More

Food Packaging Forum, 16-03-23

https://www.foodpackagingforum.org/news/eu-court-of-justice-rules-in-favor-of-echa-identifying-bpas-as-svhc

Germany introduces national water strategy as climate change forces action

2023-03-15

Germany's cabinet on Wednesday agreed on a national water strategy aimed at coping with long dry seasons and heatwaves caused by climate change to ensure water security in Europe's biggest economy in future.

Germany is a water-rich country, but weeks of high temperatures and scant rainfall in recent years have drained the water levels of the Rhine river, the country's commercial artery, and hit farmers' crops in many parts of the country.

In a first-ever national water strategy, Berlin aims to set up and protect water reservoirs in forests, floodplains, towns and villages.

The strategy, with goals to be concluded up to 2050, includes restoring forests and green spaces, and developing guidelines to regulate water distribution in case of regional shortages, through categorizing water consumers in rankings.

Local and federal governments should be able to keep an overview on where and how much water is available in the country through a new registry system, the 120-page strategy showed.

Read More

Reuters, 15-03-23

https://www.reuters.com/business/environment/germany-introduces-national-water-strategy-climate-change-forces-action-2023-03-15/

OECD eChemPortal updated with latest ECHA data

2023-03-09

We are pleased to announce that ECHA's data on more than 1.3 million endpoints for almost 26 500 substances registered under REACH is now refreshed for search on the eChemPortal.

The update includes information on more than 1 700 new substances from ECHA's database of REACH registrations, increasing the total number to 26 487 substance records. The update also includes an expansion of the data with the addition of over 215 000 more endpoint records, resulting in a total of over 1.3 million.

Read More

echemportal, 09-03-23

https://www.echemportal.org/echemportal/content/news

INTERNATIONAL

Studies detect microplastics in food and link it to packaging, processing equipment

2023-03-15

Research has shown the widespread presence of microplastics in food including fish (FPF reported), seafood (FPF reported), salts (FPF reported), honey, beer (FPF reported), and bottled water (FPF reported), and its origin from food contact articles is being increasingly investigated (FPF reported and here). Seven research studies and one book volume published between January and mid-March 2023, on microplastics in food provide more evidence of that connection. A separate review has also assessed the

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data quality of studies on plastic particles in food and proposed a protocol for that purpose.

In an article published on January 6, 2023, in the journal Environmental Science and Pollution Research, Jianqiang Zhu from Taizhou University, Zhejiang, China, and co-authors analyzed microplastics released from 354 food containers made of polystyrene (PS) into water after incubation for 30 min at 95 °C. They collected samples from different restaurants in 28 Chinese cities. The scientists detected between five and 173 plastic particles per sample. The majority of microplastics resembled the containers in composition, indicating that they "were released from their inner surface." However, 58% of the particles were made of other polymer types demonstrating that food packaging is not the only source of microplastic contamination in foods.

Based on the wide range of colors and polymer types, Pouran Makhdoumi from Kermanshah University of Medical Sciences, Iran, and co-authors, assumed microplastics present in table salts and sugars to originate from different sources, including packaging. In their article published on March 3, 2023, in the Journal of Food Composition and Analysis, they described that they analyzed packaged tables salts and sugars from four common Iranian brands. Using visual analysis (stereoscope) they identified an average of 55 particles/kg salt and 58 particles/kg sugar, while the respective amounts by Nile Red staining and fluorescence microscopy were 151 and 226 particles/kg. This shows that the type of analytical technique strongly affects the detected and reported particle number. Previous research found microplastics in 90% of tested salt brands worldwide (FPF reported).

Read More

Food Packaging Forum, 15-03-23

https://www.foodpackagingforum.org/news/studies-detect-microplastics-in-food-and-link-it-to-packaging-processing-equipmen

ECHA identifies certain brominated flame retardants as candidates for restriction

2023-03-16

ECHA has released its Regulatory Strategy for Flame Retardants, identifying aromatic brominated flame retardants as candidates for an EU-wide restriction. This would minimise the exposure of people and the environment to these persistent, potentially bioaccumulative and toxic substances.

Helsinki, 15 March 2023 – Aromatic brominated flame retardants, such as polybrominated diphenyl ethers, are generally persistent in the environment. Many, like decabromodiphenylether, are also known or suspected of being toxic and accumulating in people and animals. Their release could be minimised through an EU-wide restriction.

Before a potential restriction proposal, some preparatory work is required. This work could include an assessment of the waste stage to find out if hazardous substances are released when products containing flame retardants are dismantled, recycled, or disposed of. It could also include an assessment of the availability of suitable alternative substances or materials.

The restriction scope could cover all aromatic brominated flame retardants that are confirmed or will be confirmed to be persistent, bioaccumulative and toxic (PBT) or very persistent and very bioaccumulative (vPvB) through harmonised classification or identification as substances of very high concern (SVHCs).

For many aliphatic brominated and some organophosphorus-based flame retardants, more data is needed to determine if a restriction is necessary. These data are expected to be available from 2024 onwards, and ECHA suggests reassessing the situation for those groups in 2025.

No regulatory action is recommended for several non-halogenated subgroups of flame retardants, including certain organophosphorus-based flame retardants, since no or low hazard was identified at this time. For chlorinated flame retardants, regulatory measures are already in place or initiated.

REACH restrictions can be initiated by EU Member States or by the European Commission who can request ECHA to prepare a restriction proposal.

Background

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The strategy covers ECHA's assessment of regulatory needs for halogenated (including brominated) and organophosphorus flame retardants, which make up around 70 % of the organic flame retardants market. The strategy was announced in the Restrictions Roadmap under the EU's Chemicals Strategy for Sustainability.

The strategy identifies flame retardants, their potential hazards and information gaps. It aims to avoid regrettable substitution through grouping and gives companies more predictability through increased transparency of potential regulatory actions. Flame retardants other than halogen or organophosphorus-based will continue to be assessed in future assessments of regulatory needs (ARNs).

Read More

ECHA, 16-03-23

https://echa.europa.eu/-/echa-identifies-certain-brominated-flame-retardants-as-candidates-for-restriction

Janet's Corner

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Calibration Tools

2023-03-24

twitter.com/ErrantScience/status/1598650876947734528

Hazard Alert

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Formaldehyde

2023-03-24

Formaldehyde is a chemical compound made up of hydrogen, oxygen and carbon. It is naturally produced by all life forms as part of cell metabolism and it is written formulaically as: H-CHO. Formaldehyde is the simplest form of an aldehyde. The compound comes in various forms, including a colourless, pungent gas and a linear polymer called paraformaldehyde. A third form is the cyclic trimer metaformaldehyde. In 2011, the US National Toxicology Program categorised formaldehyde as a human carcinogen. [1,2]

USES [1,2]

Formaldehyde is used in many different applications, including construction, healthcare and automobiles. Little, if any, formaldehyde is left in consumer-ready products. In building, the compound is often used in the form of formaldehyde-based resins, which are used in flooring, support beams, shelving, moldings and furniture. When used as a building block in glue, formaldehyde makes an exceptionally strong bonding agent. In healthcare, the compound is used in vaccines, hard-gel capsules and anti-infective drugs. Formaldehyde is also used in personal care products as a preservative to kill bacteria and extend shelf-life. Finally, in automobiles, formaldehyde-based resins are used for their high temperature and physical durability.

Formaldehyde is a chemical compound made up of hydrogen, oxygen and carbon.

ROUTES OF EXPOSURE [1, 3]

- Formaldehyde does not accumulate in animals or people, as it is quickly broken down by the body's natural processes.
- People can be exposed to formaldehyde by skin contact, inhalation, or by eye contact.
- Formaldehyde is naturally found in every living organism, and is produced by humans to build basic internal materials.
- It can be found in a range of meats, fish, coffee, alcoholic beverages and fruits.

HEALTH EFFECTS

Formaldehyde poisoning can affect a range of systems and areas of the body, including the skin, and the nervous, respiratory and cardiovascular systems.

Acute Effects [3]

Severity of symptoms depends on the level and type of exposure.

- If formaldehyde is inhaled, the victim may experience a runny nose, coughing and irritation of the respiratory tract and nasal mucous membranes.
- If formaldehyde is inhaled in large quantities, there may be respiratory difficulties, including possible laryngeal spasm, a possible oedema of the upper respiratory tract and the risk of a lung oedema.
- If swallowed in small amounts, formaldehyde can cause nausea, diarrhoea and vomiting.
- If formaldehyde is swallowed in high quantities, symptoms may include CNS depression, blood in vomit and/or stool, dizziness, urine discolouration or change in composition and shock.
- Eye contact by formaldehyde will corrode the eye tissue.
- If there is skin contact, formaldehyde will cause caustic burns.

Chronic Effects [3]

Formaldehyde is toxic to multiple body systems. Long-term exposure to the compound can cause skin changes, including red and dry skin and rash or inflammation. It can also result in coughing and inflammation of the respiratory tract as well as other respiratory difficulties.

SAFETY

First Aid Measures [3]

- Ingestion: If ingested, rinse mouth and DO NOT induce vomiting. Immediately call a doctor or a poison centre.
- Ingestion in large amounts: if ingested in large quantities, take victim immediately to hospital, along with the container of vomit.
- Skin contact: In case of skin or hair contact, shower/wash immediately for at least 15 minutes with water. Remove all contaminated clothing immediately while washing. If clothes stick, do not remove. Wrap wounds with a sterile bandage. Consult doctor. If >10% of skin is covered in burns, take victim to hospital.
- Eye contact: Flush eyes carefully with water for 15 minutes. DO not apply a neutralizing agent. Take person to an ophthalmologist.
- Inhaled: Take contaminated person to nearest fresh air source and monitor their breathing. Immediately contact a doctor.

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Exposure Controls/Personal Protection [3]

- Engineering controls: Safety showers and emergency eyewash fountains should be accessible in the immediate area of the potential exposure. Ensure there is adequate ventilation. Whenever possible, material should be handled in a laboratory.
- Personal protection: Safety glasses, protective and dustproof clothing, a face shield and a gas mask with a filter type A.

REGULATION [5]

United States:

The Occupational Safety and Health Administration (OSHA) has set an 8-hour time-weighted average (TWA) concentration for formaldehyde of 0.75 parts per million (ppm). For their Short Term Exposure Limit (15 minutes), OSHA has set a limit of 2ppm.

Australia [4]

Safe Work Australia: Safe Work Australia has set an 8-hour TWA concentration for formaldehyde of 1ppm.

REFERENCES

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2. https://en.wikipedia.org/wiki/Formaldehyde
3. http://www.labchem.com/tools/msds/msds/VT310.pdf
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5. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10075&p_table=STANDARDS

Splitting seawater could provide an endless source of green hydrogen

2023-03-15

Few climate solutions come without downsides. "Green" hydrogen, made by using renewable energy to split water molecules, could power heavy vehicles and decarbonize industries such as steelmaking without spewing a whiff of carbon dioxide. But because the water-splitting machines, or electrolyzers, are designed to work with pure water, scaling up green hydrogen could exacerbate global freshwater shortages. Now, several research teams are reporting advances in producing hydrogen directly from seawater, which could become an inexhaustible source of green hydrogen.

"This is the direction for the future," says Zhifeng Ren, a physicist at the University of Houston (UH). However, Md Kibria, a materials chemist at the University of Calgary, says for now there's a cheaper solution: feeding seawater into desalination setups that can remove the salt before the water flows to conventional electrolyzers.

Today, nearly all hydrogen is made by breaking apart methane, burning fossil fuels to generate the needed heat and pressure. Both steps release carbon dioxide. Green hydrogen could replace this dirty hydrogen, but at the moment it costs more than twice as much, roughly $5 per kilogram. That's partly due to the high cost of electrolyzers, which rely on catalysts made from precious metals. The U.S. Department of Energy recently launched a decadelong effort to improve electrolyzers and bring the cost of green hydrogen down to $1 per kilogram.

If they succeed and green hydrogen production skyrockets, pressure could build on the world's freshwater supplies. Generating 1 kilogram of hydrogen using electrolysis takes some 10 kilograms of water. Running trucks and key industries on green hydrogen could require roughly 25 billion cubic meters of fresh water a year, equivalent to the water consumption of a country with 62 million people, according to the International Renewable Energy Agency.

Seawater is nearly limitless, but splitting it comes with its own problems. Electrolyzers are built much like batteries, with a pair of electrodes surrounded by a watery electrolyte. In one design, catalysts at the cathode split water molecules into hydrogen (H+) and hydroxyl (OH-) ions. Excess electrons at the cathode stitch pairs of hydrogen ions into hydrogen gas (H2), which bubbles out of the water. The OH- ions, meanwhile, travel

Chemists improve electrolyzers to withstand saltwater corrosion.

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through a membrane between the electrodes to reach the anode, where catalysts knit the oxygen into oxygen gas (O2) that is released.

When seawater is used, however, the same electrical jolt that generates O2 at the anode also converts the chloride ions in saltwater into highly corrosive chlorine gas, which eats away at the electrodes and catalysts. This typically causes electrolyzers to fail in just hours when they can normally operate for years.

Now, three groups are reporting efforts to halt this corrosion. Researchers led by Nasir Mahmood, a materials scientist at RMIT University, Melbourne, reported in the 8 February issue of Small that by coating their electrodes with negatively charged compounds such as sulfates and phosphates, they could repel negatively charged chloride ions and prevent the formation of chlorine gas. The RMIT team reported virtually no degradation in its electrodes for up to 2 months, although it generated only a trickle of hydrogen. Since then, in unpublished work, the researchers have bolstered their setup to produce hydrogen as fast as commercial freshwater electrolyzers, Mahmood says.

Shizhang Qiao, a nanotechnologist at the University of Adelaide, and his colleagues made changes to a second type of electrolyzer that uses a membrane permeable only to H+ ions. This setup split water molecules at the anode instead of the cathode, snatching away electrons to free H+ ions. The ions migrate through the membrane to the cathode where they combine with electrons to make H2. Qiao and his colleagues coated their electrodes with chromium oxide, which attracted a bubble of OH- ions that repelled chloride ions. The device split seawater for 100 hours at high currents without degradation, they report in the 30 January issue of Nature Energy. "I'm very happy to see such a clever design," says UH materials physicist Shou Chen.

Zongping Shao, a chemical engineer at the Nanjing University of Technology, and his colleagues took a third tack to fending off chloride. They surrounded the electrodes with membranes that only allow freshwater vapor to pass through from the surrounding bath of seawater. As the electrolyzer converts fresh water to hydrogen and oxygen, it creates a pressure that draws more water molecules through the membrane, replenishing the freshwater supply. In the 30 November 2022 issue of Nature, Shao and his colleagues reported their setup operated for 3200 hours with no sign of degradation. "It's like an internal distillation process," says Haotian Wang, an applied physicist at Rice University

The membranes that screen out the salt resemble those in commercial desalination plants, which are already efficient enough to produce fresh water while adding only about $0.01 per kilogram to green hydrogen's cost. That's why Kibria says fiddling with electrolyzers doesn't make as much sense as simply attaching green hydrogen projects to desalination plants. "We don't need to reinvent the wheel," he says. "This is a solved problem."

Mahmood disagrees. For starters, he says, desalination isn't a ready option for countries that can't afford large-scale capital projects. Moreover, he says, corrosion-resistant electrodes may also be useful for tapping other impure water sources, such as wastewater and brackish water. "We need to keep working on alternative technologies," he says.

Science, 15 March 2023

https://science.org

Scientists Warn: Common Cleaning Chemical Linked to 500% Increased Risk of Parkinson's Disease

2023-03-14

A common and widely used chemical may be fueling the rise of the world's fastest-growing brain condition – Parkinson's disease. For the past 100 years, trichloroethylene (TCE) has been used to decaffeinate coffee, degrease metal, and dry clean clothes. It contaminates the Marine Corps base Camp Lejeune, 15 toxic Superfund sites in Silicon Valley, and up to one-third of groundwater in the U.S. TCE causes cancer, is linked to miscarriages and congenital heart disease, and is associated with a 500% increased risk of Parkinson's disease.

According to the National Cancer Institute, TCE is present in some household products, including cleaning wipes, aerosol cleaning products, tool cleaners, paint removers, spray adhesives, carpet cleaners, and spot removers.

In a hypothesis paper published today (March 14) in the Journal of Parkinson's Disease, an international team of researchers—including University of Rochester Medical Center (URMC) neurologists Ray Dorsey, MD, Ruth Schneider, MD, and Karl Kieburtz, MD—postulate that TCE may be an invisible cause of Parkinson's. In the paper, they detail the widespread use of the chemical, the evidence linking the toxicant to Parkinson's, and profile seven individuals, ranging from a former NBA basketball player to a Navy captain to a late U.S. Senator, who developed

TCE is present in some household products, including cleaning wipes, aerosol cleaning products, tool cleaners, paint removers, spray adhesives, carpet cleaners, and spot removers.

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Parkinson's disease either after likely working with the chemical or being exposed to it in the environment.

A ubiquitous and widespread industrial pollutant

TCE was a widely used solvent employed in a number of industrial, consumer, military, and medical applications, including to remove paint, correct typewriting mistakes, clean engines, and anesthetize patients. Its use in the U.S. peaked in the 1970's, when more than 600 million pounds of the chemical—or two pounds per American—were manufactured annually. Some 10 million Americans worked with the chemical or other similar industrial solvents. While domestic use has since fallen, TCE is still used for degreasing metal and spot dry cleaning in the U.S.

TCE contaminates countless sites across the country. Half of the most toxic Environmental Protection Agency's Superfund sites contain TCE. Fifteen sites are in California's Silicon Valley where the chemicals were used to clean electronics and computer chips. TCE is found in numerous military bases, including Camp Lejeune in North Carolina. From the 1950s to the 1980s a million Marines, their families, and civilians that worked or resided at the base were exposed to drinking water levels of TCE and perchloroethylene (PCE), a close chemical cousin, that were up to 280 times above what is considered safe levels.

TCE and Parkinson's disease

The connection between TCE and Parkinson's was first hinted at in case studies more than 50 years ago. In the intervening years, research in mice and rats have shown that TCE readily enters the brain and body tissue and at high doses damages the energy-producing parts of cells known as mitochondria. In animal studies, TCE causes selective loss of dopamine-producing nerve cells, a hallmark of Parkinson's disease in humans.

Individuals who worked directly with TCE have an elevated risk of developing Parkinson's. However, the authors warn that "millions more encounter the chemical unknowingly through outdoor air, contaminated groundwater, and indoor air pollution."

The chemical can contaminate soil and groundwater leading to underground rivers, or plumes, that can extend over long distances and migrate over time. One such plume associated with an aerospace company on Long Island, New York, is over four miles long and two miles wide, and has contaminated the drinking water of thousands. Others are found everywhere from Shanghai, China, to Newport Beach, California.

Beyond their risks to water, the volatile TCE can readily evaporate and enter people's homes, schools, and work places, often undetected. Today, this vapor intrusion is likely exposing millions who live, learn, and work near former dry cleaning, military, and industrial sites to toxic indoor air. Vapor intrusion was first reported in the 1980s when radon was found to evaporate from soil and enter homes and increase the risk of lung cancer. Today millions of homes are tested for radon, but few are for the cancer-causing TCE.

Decades before symptoms appear

The piece profiles seven individuals where TCE may have contributed to their Parkinson's disease. While the evidence linking TCE exposure to Parkinson's disease in these individuals is circumstantial, their stories highlight the challenges of building the case against chemical. In these cases, decades have often passed between exposure to TCE and the onset of Parkinson's symptoms.

The case studies include the professional basketball player Brian Grant, who played for 12 years in the NBA, and was diagnosed with Parkinson's at age 36. Grant was likely exposed to TCE when he was three years old and his father, then a Marine, was stationed at Camp Lejeune. Grant has created a foundation to inspire and support people with the disease.

Amy Lindberg was similarly exposed to the contaminated drinking water at Camp Lejeune while serving as a young Navy Captain and would go on to be diagnosed with Parkinson's disease 30 years later. The piece details others whose exposure was the result of living close to a contaminated site or working with the chemical, including the late U.S. Senator Johnny Isakson, who stepped down from office after a Parkinson's diagnosis in 2015. Fifty years earlier, he served in the Georgia Air National Guard, which used TCE to degrease airplanes.

Addressing the threat to public health

The authors note that "for more than a century, TCE has threatened workers, polluted the air we breathe—outside and inside—and contaminated the water we drink. Global use is waxing, not waning."

The authors proscribe a series of actions to address the public health threat posed by TCE. They note that contaminated sites can be successfully remediated and indoor air exposure can be mitigated by vapor remediation systems similar to those used for radon. However, the U.S.

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alone is home to thousands of contaminated sites and this process of cleaning and containment must be accelerated.

They argue for more research to better understand how TCE contributes to Parkinson's and other diseases. TCE levels in groundwater, drinking water, soil, and outdoor and indoor air require closer monitoring and this information needs to be shared with those who live and work near polluted sites.

In addition, the authors call for finally ending the use of these chemicals in the U.S. PCE is still widely used today in dry cleaning and TCE in vapor degreasing. Two states, Minnesota and New York, have banned TCE, but the federal government has not, despite findings by the EPA as recently at 2022 that the chemicals pose "an unreasonable risk to human health."

Sci Tech Daily, 14 March 2023

https://scitechdaily.com

Active volcano on Venus shows it's a living planet

2023-03-15

Eruption spotted in 30-year-old data from Magellan mission

Choked by a smog of sulfuric acid and scorched by temperatures hot enough to melt lead, the surface of Venus is sure to be lifeless. For decades, researchers also thought the planet itself was dead, capped by a thick, stagnant lid of crust and unaltered by active rifts or volcanoes. But hints of volcanism have mounted recently, and now comes the best one yet: direct evidence for an eruption. Geologically, at least, Venus is alive.

The discovery comes from NASA's Magellan spacecraft, which orbited Venus some 30 years ago and used radar to peer through the thick clouds. Images made 8 months apart show a volcano's circular mouth, or caldera, growing dramatically in a sudden collapse. On Earth, such collapses occur when magma that had supported the caldera vents or drains away, as happened during a 2018 eruption at Hawaii's Kilauea volcano. "I'm totally tickled, as a geomorphologist, to see this," says Martha Gilmore, a planetary scientist at Wesleyan University who was not involved in the study.

Witnessing this unrest during the short observation period suggests either Magellan was spectacularly lucky, or, like Earth, Venus has many volcanoes spouting off regularly, says Robert Herrick, a planetary scientist at the University of Alaska, Fairbanks. Herrick, who led the study, says, "We can rule out that it's a dying planet."

The discovery, published today in Science and presented at the Lunar and Planetary Science Conference, makes Venus only the third planetary body in the Solar System with active magma volcanoes, joining Earth and Io, Jupiter's fiery moon. It means future missions to Venus will be able to study "bare, gorgeous new rock" that provides a sample of the planet's interior, Gilmore says. The discovery of more volcanoes, in old or future data, will also help scientists understand how Venus is shedding its interior heat and evolving. And it will shake scientists out of their long-standing view that a spasm of activity a half-billion years ago repaved the planet's surface—as evidenced by a relative paucity of impact craters—and was followed by a long period of quiet. "We've all had our stagnant-lid lenses on to understand the planet," says Suzanne Smrekar, a planetary scientist at NASA's Jet Propulsion Laboratory (JPL). "We're finally getting an eye correction."

Recent years had brought hints that Venus has some geologic life. In 2010, researchers on the European Space Agency's Venus Express mission detected three anomalously hot regions, which they interpreted as lava flows a few million years old that hadn't yet cooled off. A couple of years later, the spacecraft found atmospheric spikes of sulfur dioxide, suggesting it was supplied by a variable source, such as volcanoes. And in 2021, a reanalysis of Magellan data indicated large blocks of crust had been jostled around like pack ice—a sign of rock stirring below the surface.

Prompted by these hints, Herrick decided to take another look at the Magellan data. "It's essentially looking for a needle in a haystack with no guarantee there's a needle there," he says. He targeted obvious candidates, such as Maat Mons, a volcano taller than Mount Everest. Magellan had already found that the force of gravity above it was surprisingly low—a sign that a hot plume of less-dense rock from the mantle might be fueling it, like the plume that sits beneath Hawaii. And microwave radiation from the summit suggested its surface had the chemistry of fresh lava.

Herrick had an unlikely ally in his search: endless pandemic Zoom meetings, which gave him time to compare radar images made at different times. "If anyone asks about a specific meeting, I was fully attentive at that one," he jokes.

The hunt was hard. At a resolution of several hundred meters, Magellan images are relatively coarse, only sensitive to the biggest changes in the landscape. Moreover, during its 5-year mission, the spacecraft revisited the same spots at most three times, and during its second campaign, its radar

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had been rotated 180°. Comparing ground features from opposite angles is far from intuitive, Herrick says. "The same things look quite different."

But after hundreds of hours of tedious comparisons, covering less than 2% of the venusian surface, Herrick spotted what looked like a changed caldera. To avoid being fooled, he contacted Scott Hensley, a radar specialist at JPL well-known for debunking past false alarms in Magellan data. Hensley modeled what an unchanged caldera should have looked like during the second Magellan pass—starkly different from what was observed. The second image also appeared to show fresh lava flows, but those could have been hidden from view during the first pass, Herrick cautions. Still, the caldera changes are unequivocal evidence of volcanic activity, Smrekar says.

The discovery is just a preview of what is likely to come with three new Venus missions due to launch in the next decade: the European EnVision orbiter and NASA's DAVINCI and VERITAS missions. Both EnVision and VERITAS will be equipped with sharper radar vision than Magellan, making them well suited to monitoring the burps and twitches of a living planet, Herrick says. "We're guaranteed to see some really big changes."

Science, 15 March 2023

https://science.org

Humble tea's antidepressant properties confirmed

2023-03-19

A tea that's been around for more than 900 years might be just what the doctor ordered as a treatment for depression, a new study has revealed. Already renowned for its health benefits, researchers have now demonstrated matcha tea's antidepressant-like effects.

Matcha tea is a fine powder made from the leaves of the Camellia sinensis plant, the same plant used to produce white, green, black and oolong teas. In recent years, the health benefits of matcha tea have been touted due to its high concentration of antioxidants and anti-inflammatory substances. Matcha tea is also thought to reduce anxiety and elevate mood.

Depression is the most prevalent psychiatric disorder worldwide and can significantly impair daily functioning. In the US, one in five adults will struggle with a depressive disorder at some point in their lifetime. Although the onset varies among people, the mechanism underlying depression is thought to be caused by reduced dopaminergic function in the brain.

Giving stressed mice matcha tea activated the parts of the brain that produce dopamine, a mood-enhancing substance that is lacking in people with depression.

Dopamine is the "feel good" neurotransmitter and hormone responsible for feelings of pleasure, satisfaction, and motivation. Post-mortem examinations have shown that dopamine D1 receptor expression and function are significantly reduced in patients with major depressive disorder.

Conventional antidepressants such as selective serotonin reuptake inhibitors (SSRIs), serotonin and norepinephrine reuptake inhibitors (SNRIs) and tricyclic antidepressants can successfully treat depression by increasing dopamine, serotonin, and norepinephrine levels in the brain. Still, they have many side effects, and people can develop resistance to them.

Enter the humble matcha tea as a safe, natural alternative. Although there is plenty of anecdotal evidence that drinking matcha tea improves mood, there have been no scientific studies exploring its antidepressant properties. Researchers from Kumamoto University in Japan had previously found that Matcha tea improved anxiety levels in healthy mice by activating dopamine D1 receptors. Now, they wanted to look more closely at the effect of the tea on the brain's circuitry.

The researchers subjected genetically modified stress-tolerant (BALB/c) and stress-susceptible (C57BL/6J) mice to social isolation. They found that giving both sets of mice matcha tea only reduced depression in the stress-susceptible mice.

"Matcha tea reduced the immobility time only in stress-susceptible mice that experienced greater stress from social isolation, and exhibited high depression-like behavior, in comparison to the stress-tolerant mice," said Dr Yuki Kurauchi, the study's lead author.

Immobility time is a measure of behavioral despair in mice, and increased immobility time is an indicator of depression.

Wanting to understand more, the researchers performed an immunohistochemical analysis of the brains of the mice, a way of combining anatomical, immunological, and biochemical techniques to image discrete tissue components. They found that, in stress-susceptible mice, matcha tea activated the brain's prefrontal cortex (PFC) and the nucleus accumbens (NAc).

The PFC is the area of the brain that is most sensitive to stress, whereas the NAc plays a key role in processing rewarding stimuli. Importantly, both are crucial for controlling the brain's dopamine levels. Activation of the

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PFC and the NAc causes a surge in dopamine levels, improving mood. This effect was not seen in the stress-tolerant mice. Moreover, when the stress-susceptible mice were given a dopamine D1 receptor blocker, the effects of the matcha tea were negated.

"These results suggest that matcha tea powder exerts an antidepressant-like effect by activating the dopaminergic system of the brain, and this is influenced by the mental state of the individual," Kurauchi said.

The researchers' findings have implications for future research and the development of new antidepressant medications. In the meantime, they recommend raising a cup of matcha tea.

"Incorporating matcha into health promotion programs has potential to improve its widespread utility," Kurauchi said.

The study was published in the journal Nutrients.

New Atlas, 19 March 2023

https://newatlas.com

World's largest ever endometriosis study uncovers genetic pain link

2023-03-13

An estimated 190 million of women around the world suffer from endometriosis, yet the debilitating condition has no cure, and its broad cache of symptoms has seen it take on average around eight years to even be diagnosed, let alone treated.

Now, in the largest study of its kind, the genomes of 60,674 of those suffering from endometriosis across 25 datasets have been analyzed alongside the genetic maps of 701,926 women and girls of reproductive age without the condition. The study was able to identify 42 common regions linked to the condition, more than double what was previously known.

"Using different datasets of women with and without endometriosis, some of which had unprecedented detailed data on surgical findings and pain experience collected using standardized criteria, allowed us to generate a treasure trove of new information about genetically driven endometriosis subtypes and pain experience," said Nilufer Rahmioglu, senior researcher at the University of Oxford and lead author of the study.

An estimated 190 million of women around the world suffer from endometriosis, yet the debilitating condition has no cure.

What's more, the study uncovered a shared genetic basis for sufferers to also be more susceptible to other types of chronic pain unrelated to endometriosis, including migraine, back pain and multi-site conditions.

"Very little is known about the causes of endometriosis, but studying genetics can give us clues to the biological processes that are the basis for onset and progression," said Sally Mortlock, from University of Queensland's Institute for Molecular Bioscience in Australia, a collaborator on the study. "Before this study there were 17 genetic regions associated with endometriosis and now we have 42 regions with much richer data.

"It means we can find out what genes in these regions do and find new drug targets, leading to new treatments," she added.

The 42 regions showed genetic variants that increase the risk of endometriosis, so it opens the door for better targeted therapies that address different subtypes of the disease. While the condition is characterized by the presence of tissue that resembles uterine lining outside of the uterus, the location of these deposits varies greatly, as do the symptoms associated with them. Chronic and intensive pelvic pain, fatigue, depression, anxiety, nausea and infertility are just some of the huge range of symptoms sufferers experience.

Because of how many ways it presents in symptoms, as well as systemic issues surrounding its seriousness, endometriosis has been notoriously slow to be diagnosed. Having a much clearer genetic map of the condition promises to speed up the diagnostic process, as well as open the door for less invasive procedures and the development of non-hormonal treatment and pain-relief therapies.

"Endometriosis is now recognized as a major health issue affecting women's lives," said Krina Zondervan, professor at the University of Oxford and senior author of the study. "It has provided a wealth of new knowledge on the genetics underlying endometriosis, which will help the research community in their efforts to come up with new treatments and possibly new ways of diagnosing the disease benefiting millions of women worldwide."

The research was published in the journal Nature Genetics.

New Atlas, 13 March 2023

https://newatlas.com

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Study hints at the promise of non-hallucinogenic LSD for treating mood disorders

2023-03-17

Mood disorders are mental health conditions characterized by persistently dysregulated moods, such as recurring feelings of depression or euphoria. According to statistics by the National Institutes of Health, approximately 1 in 5 people in the United States will experience mood disorders at some point in their life.

Given their high incidence and their highly debilitating effects, identifying effective treatments for these disorders is of utmost importance. While there are now countless antidepressant medications on the market, patients tend to respond to each of them differently and some also cause undesirable side effects.

Neuroscientists and pharmacology experts are thus continuously trying to identify alternative pharmacological treatments that might alleviate symptoms of mood disorders with minimal side effects. In recent years, some research teams have been particularly exploring the therapeutic potential of lysergic acid diethylamide (LSD), a psychedelic drug that typically causes hallucinations, as well as intensified emotions and perceptions.

Researchers at Carleton University, BetterLife Pharma Inc., the Medical College of Wisconsin and University of California San Diego (UCSD) have recently carried out a study exploring the potential of a non-hallucinogenic version of LSD for treating mood disorders. Their findings, published in Cell Reports, suggest that non-hallucinogenic LSD could have positive effects of mood, while also reducing the need for medical supervision while taking the drug.

"Since my lab started, we have been working on elucidating the mechanism of action of ketamine as an antidepressant and have a standing interest in identifying new potential treatments for mood disorders," Dr. Argel Aguilar Valles, co-lead author of the paper, told Medical Xpress. "In the winter of 2021, I was contacted by BetterLife Pharma to collaborate with them in demonstrating the potential of 2-Br-LSD to increase neuronal plasticity and induce behavior in mice that are relevant for antidepressant therapies."

The recent paper published in Cell Reports was a collective research effort involving separate experiments conducted at Medical College of Wisconsin, Carleton University, and UCSD. These distinct experiments

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were all aimed at exploring the therapeutic potential and effects of 2-Br-LSD, a non-hallucinogenic analog of LSD created by the pharmacological company BetterLife.

A first research team, led by co-lead author Dr. John McCorvy at Medical College of Wisconsin, specifically tried to identify the pharmacological targets of 2-Br-LSD. This was done using a high-throughput screening platform capable of measuring GPCR activity for over 30 different neurotransmitter receptors and determine whether 2-Br-LSD activated, inhibited or did not affect the activity of each of these receptors.

"It was necessary to test 2-Br-LSD at several molecular targets because LSD interacts with many GPCRs," Dr. Mc Corvy explained. "We needed to uncover molecular targets that were distinct from LSD to determine what makes 2-Br-LSD non-hallucinogenic and why it is capable of therapeutic potential and worthy of further testing in vivo."

A second team of researchers led by Dr. Adam Halberstadt at UCSD tested whether 2-Br-LSD induced the so-called head twitch response (HTR) in mice. As suggested by its name, this is a rapid side-to-side head movement typically observed in mice while they are under the influence of psychedelic drugs, including conventional hallucinogenic LSD, but not after consuming non-hallucinogenic analogs.

"While LSD induced the HTR in our studies, 2-Br-LSD did not induce any head twitches even after administration of relatively high doses, which supports the classification of 2-Br-LSD as a non-hallucinogenic 5-HT2A agonist," Dr. Halberstadt said. "That is a key finding because what is really novel about 2-Br-LSD is that it may mimic some of the therapeutic-like effects of LSD despite being non-hallucinogenic. Therefore, it is important to generate data confirming that 2-Br-LSD doesn't act as a hallucinogen."

In addition to not causing the HTR in mice, 2-Br-LSD activated the 5-HT2A receptor (i.e., the primary target of psychedelic drugs) in the mice brain to a lesser extent than hallucinogenic LSD. This weaker activation could potentially explain why this analog drug does not produce hallucinations in humans and HTR in mice.

"Nevertheless, 2-Br-LSD is still active at 5-HT2A and seems to retain enough activity to potentially induce therapeutic effects," Dr. Halberstadt explained.

Drs. McCorvy, Halberstadt and his colleagues also found that 2-Br-LSD did not activate the 5-HT2B receptor, also known as serotonin receptor 2B. This

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is a receptor located in several areas of the peripheral and central nervous system, which has been linked to cardiac function.

"5-HT2B activation can be a problem because over time it can damage the valves in the heart, which is why the anorectic drug fenfluramine was taken off the market," Dr. Halberstadt said. "While LSD acts as a potent 5-HT2B agonist, we found that 2-Br-LSD is not active at 5-HT2B, meaning it may have less potential to produce cardiac side-effects."

Ultimately, the research group led by Dr. Aguilar Valles at Carleton University carried out a series of experiments on cultured neurons and living mice, to test the effects of 2-Br-LSD on mood. Firstly, they collected measurements to determine whether 2-Br-LSD increased the morphological complexity of cultured rat neurons. Morphological complexity is a measure of neuronal plasticity, or in other words the brain's ability to change the function, structure and organization of neurons over time.

"We then measured stress-coping behavior in mice and demonstrated that 2-Br-LSD, similar to other effective antidepressants, increased active stress-coping behaviors and reversed the effects of chronic stress, a key risk factor for depression and other mood disorders," Dr. Aguilar Valles explained. "We also demonstrated that activation of one of the identified 2-Br-LSD receptors (the serotonin receptor 5HT2A) is required for 2-Br-LSD to induce these effects (on cultured neurons and in mouse behavior)."

The findings gathered by Drs. Aguilar Valles, Halberstadt, McCorvy and their colleagues suggest that the pharmacological profile of 2-Br-LSD is far more specific and desirable for the treatment of mood disorders than that of its hallucinogenic counterpart. In addition, the targeted action of 2-Br-LSD on receptors could reduce the risk of undesirable side effects on the cardiac system that some studies linked with the consumption of conventional, hallucinogenic LSD.

"The work of co-lead Dr. Adam Halberstadt confirmed that 2-Br-LSD is not hallucinogenic, as also indicated by studies on humans," Aguilar Valles said.

"If proven safe and effective in treating mood disorders in human patients, non-hallucinogenic derivatives of serotonergic psychedelic drugs could be used more widely than their hallucinogenic counterparts for therapeutic purposes, because they may require less clinical supervision."

Overall, the results of this collaborative research effort suggest that non-hallucinogenic LSD analogs, and particularly 2-Br-LSD, could be promising

treatments for mood disorders. In addition, the researchers found that they could potentially also serve as anxiolytics, drugs to ease feelings of anxiety.

Before these drugs can be used on human patients, however, they will need to undergo clinical trials on humans to verify their safety and effectiveness. In the meantime, Dr. Aguilar Valles and his lab will continue exploring the neuronal mechanisms underlying the functioning of non-hallucinogenic LSD, as well as other potentially viable antidepressant treatments.

"We want to continue our work on the neuronal mechanisms that this type of drug activates and compare them with the effects of other proven effective antidepressants," Dr. Aguilar Valles added. "We hope to identify markers or mechanisms shared by drugs with similar antidepressant profiles, so that we can improve our screening process of potential pharmacotherapies for mood disorders."

Medical Xpress, 17 March 2023

https://medicalexpress.com

Synthetic proteins simplify nature to outperform the real thing

2023-03-20

Creating synthetic proteins is a promising avenue of study, but could we take shortcuts on nature's blueprint and make more efficient versions? Scientists at UC Berkeley have found that simpler combos of synthetic building blocks can make for protein alternatives that work just as well as, and in some cases better than, the real thing.

Although hundreds of types of amino acids exist, natural selection has picked 20 that can be found in every living organism on Earth. This core set combines together into hundreds of thousands of different variations to create every protein in your body.

In recent years scientists have been experimenting with creating artificial proteins, making strides towards treating diseases like Alzheimer's and malaria. These are usually made by trying to replicate the complex structures and recipes that nature has cooked up over billions of years – but is that really the most efficient method?

In the UC Berkeley study, scientists investigated much simpler synthetic substitutes. First they trained AI systems on a database of about 60,000

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natural proteins. Then the AI is tasked with figuring out how to recreate specific properties and functions of proteins from only a handful of "building blocks" – monomers currently used in plastics.

Rather than using all 20 amino acids found in natural proteins, the team found that the AI could choose the right number, type and arrangement of monomers to recreate functioning proteins using just two, four or six building blocks. They called their protein substitutes random heteropolymers (RHPs).

In one experiment, the researchers created an artificial blood plasma using RHPs that were specially designed to dissolve and stabilize natural protein biomarkers in blood. Not only could this fluid preserve them without refrigeration, but it managed to improve on the natural stuff by helping the proteins survive higher temperatures.

While it might sound like taking shortcuts would lead to an inferior product, the team says the technique is about removing inactive "junk" that accumulates in proteins after billions of years of trial and error.

"Nature doesn't do a lot of bottom-up, molecular, precision-driven design like we do in the lab," said Ting Xu, lead author of the study. "Nature needs flexibility in order to get where it is. Nature doesn't say, let's study the structure of this virus and make an antigen to attack it. It's going to express a library of antigens and from there pick the one that works."

Importantly, the artificial plastic RHPs work right alongside biological systems without causing trouble. In another test, the researchers created artificial cytosol, the fluid inside cells, and found that the natural protein-producing ribosomes continued to do their work as usual, even in the artificial fluid.

"Basically, all the data shows that we can use this design framework, this philosophy, to generate polymers to a point that the biological system would not be able to recognize if it is a polymer or if it is a protein," said Xu. "We basically fool the biology. The whole idea is that if you really design it and inject your plastics as a part of an ecosystem, they should behave like a protein. If the other proteins are like, 'Okay, you are part of us,' then that's OK."

While there's still plenty of work left to do, the team says that RHPs could eventually help make for more biocompatible materials, such as implants, or better drug delivery systems.

The research was published in the journal Nature.

New Atlas, 20 March 2023

https://newatlas.com

Every stage of plastic production and use is harming human health: Report

2023-03-21

Plastic production is on track to triple by 2050, a potential influx of hazardous materials that the Earth and humans can't handle, according to a new report from the Minderoo-Monaco Commission on Plastics and Human Health.

Experts say the report is one of the most comprehensive to date in compiling evidence of plastics' risks for humans, the environment and the economy at every stage of their lifecycle. The commission — a group of researchers organized by the Australian foundation Minderoo, the Scientific Center of Monaco and Boston College — found plastics disproportionately harm low-income communities, people of color and children. They're urging negotiators of the United Nations Global Plastics Treaty to take bold steps, such as capping plastic production, banning some single-use plastics and regulating the toxic chemicals added to plastics. Countries launched the plastics treaty process in March 2022, with the goal of adopting it in 2024.

From production through disposal, plastics impact people and the environment. At fossil fuel extraction sites (most plastics are made from fossil fuels like oil or natural gas) and plastic production facilities workers and surrounding communities are exposed to pollutants that can cause reproductive complications such as premature births and low birth weights, lung cancer, diabetes and asthma, among other illnesses.

Use of plastic products can expose people to toxic chemicals, including phthalates, which are linked to brain development problems in children, and BPA, which is linked to heart attacks and neurological issues. At the end of the plastics supply chain are growing landfills that leach harmful materials into the environment and surrounding communities. These landfills are often found in poor countries, described in the report as "pollution havens."

"The bottom line is that plastic is not nearly as cheap as we thought it was, it's just that the costs have been invisible," Dr. Philip Landrigan,

New report recommends the United Nations Global Plastics Treaty significantly reduce plastic use through aggressive bans and caps, and closer examination of toxic ingredients.

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a pediatrician, director at the Boston College Global Observatory on Planetary Health and lead author of the report, told Environmental Health News (EHN). In fact, health-related costs resulting from plastic production were more than $250 billion in 2015, the report found.

He explained that the commission's recommendations for those discussing the treaty could prevent many of those costs to environmental health and the economy.

Plastics production caps and bans

"There needs to be a global cap on plastic production," Dr. Landrigan said. This cap would allow some plastic production, but prevent the anticipated growth of plastics in the coming years. Production is increasing in part because the fossil fuel industry is looking for new markets as rising demand for renewable energy could decrease the need for fuel, the report says.

The commission hopes countries signing the Global Plastics Treaty will ban avoidable plastics alongside capping production. Roughly 35% to 40% of plastic goes into disposable single-use items, and that fraction is expected to increase.

"We need to get in charge again of why we use plastic," Jane Muncke, managing director and chief scientific officer at the Food Packaging Forum who was unaffiliated with the report, told EHN.

Plastic waste and health harms

Less than 10% of plastics are reused or recycled, according to the report, and the rest is burned or goes into landfills with devastating human and environmental tolls. Areas where plastic is burned experience elevated pollution and health risks. For example, plastic burning is linked to about 5.1% of lung cancers in cities in India, according to the report. Waste from electronics, with plastic and metal components, creates harmful exposures for the people around them, including roughly 18 million children working with electronic waste, the report says.

For plastics that remain on the market, the commission hopes to see improved health and safety testing of the thousands of chemicals added to plastics. There are more than 2,400 chemicals added to plastics that are considered a high risk, the report says, and many others have never been tested.

"The burden of proof that a chemical is problematic ends up being on society, when people start having health problems," Andrea Gore, a professor of pharmacology and toxicology at the University of Texas at Austin, told EHN. To change this, the commission proposes testing chemicals for toxicity before they're added to plastic products that are sold.

Exposure to plastics "falls most heavily on poor people, minorities, Indigenous populations, and of course, kids," Dr. Landrigan said. He explains that generally, poor countries facing plastic pollution want to see global commitments to reduce plastics and their health harms, while countries that produce plastics might be wary of regulations that reduce the industry's profits.

"It'll spin out of control"

The second negotiation meeting for the Global Plastics Treaty will start in Paris in late May. The initial meeting covered procedures and included representatives from 160 countries. It saw conflict between the High Ambition Coalition, made up of 40 countries who advocate for the treaty to include mandatory actions, and others, including the United States, who want the treaty to result in pledges from each country.

For individuals concerned about plastic in their own life, Gore recommends reducing contact with plastic wherever is practical and avoiding heating plastic in the microwave, which can leach toxics.

"Don't panic, because it is easy to get very alarmed," she said. "This document gave me hope and has very strong recommendations."

Dr. Landrigan points out that while reducing harms from plastic can seem daunting, there are examples of policy changing the environment for the better, such as the Clean Air Act, which reduced U.S. air pollution by 77% from 1970 to 2019. But, he said, "if we don't act courageously and just let the plastic crisis continue to escalate, it'll spin out of control."

Environmental Health News, 21 March 2023

https://ehn.org

BPA-like chemical seeps from labels to food

2023-03-16

Steps were taken in Canada to reduce the use of Bisphenol A (BPA), a toxic chemical linked to prostate and breast cancer, commonly found in plastics,

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the lining of food cans, water bottles, and paper receipts. But in many cases, it has been replaced with similar hormone disrupting chemicals, like Bisphenol S (BPS).

"BPA is a chemical that can interfere with hormones in the human body and cause adverse health outcomes, including cancers, diabetes, and damage to fertility and the development of infants. Now there is growing evidence that BPS may have similar health effects," says Stéphane Bayen, an associate professor in the food science and agricultural chemistry department at McGill University.

"Our study provides evidence, for the first time, that BPS and alternative chemicals found in food labels migrate through packaging materials into the food people eat," he explains.

The researchers examined an assortment of packaged fresh food sold in Canada such as meats, cheeses, vegetables, and bakery products. They also compared fish bought from stores in Canada and the United States, and the differences between food wrapped with plastic cling wrap films with or without food labels.

They found relatively high concentrations of BPS in thermal food labels, like price tags and stickers, where heat is used to print bar codes or unit prices. In contrast, they found little to no BPS in plastic wrapper films, pads, and trays.

While Canada does not currently regulate BPS, the researchers show that the amount of BPS found in the foods studied significantly exceeded the European Union limit, which regulates the permitted amount of substances released from packaging materials in contact with food.

"Considering the number of packaged food items sold with thermal labels, the actual dietary intake of BPS and other chemicals is likely to be high," says Bayen.

The study, published in Environmental Science & Technology, suggests a more thorough risk assessment of BPS and its ability to migrate into food from packaging is needed to help develop regulatory guidelines in the food sector.

Bisphenol S (BPS), a hormone disrupting chemical, migrates from labels on packaging materials into food, a new study from Canada finds.

The study received support from a Canadian Institutes of Health Research (CIHR) Institute of Population and Public Health Team grant and McGill University.

Futurity, 16 March 2023

https://futurity.org

Blueberries have joined green beans in this year's Dirty Dozen list

2023-03-15

Blueberries, beloved by nutritionists for their anti-inflammatory properties, have joined fiber-rich green beans in this year's Dirty Dozen of nonorganic produce with the most pesticides, according to the Environmental Working Group, a nonprofit environmental health organization.

In the 2023 Shopper's Guide to Pesticides in Produce, researchers analyzed testing data on 46,569 samples of 46 fruits and vegetables conducted by the US Department of Agriculture. Each year, a rotating list of produce is tested by USDA staffers who wash, peel or scrub fruits and vegetables as consumers would before the food is examined for 251 different pesticides.

As in 2022, strawberries and spinach continued to hold the top two spots on the Dirty Dozen, followed by three greens — kale, collard and mustard. Listed next were peaches, pears, nectarines, apples, grapes, bell and hot peppers, and cherries. Blueberries and green beans were 11th and 12th on the list.

A total of 210 pesticides were found on the 12 foods, the report said. Kale, collard and mustard greens contained the largest number of different pesticides — 103 types — followed by hot and bell peppers at 101.

"Some of the USDA's tests show traces of pesticides long since banned by the Environmental Protection Agency. Much stricter federal regulation and oversight of these chemicals is needed," the report said.

"Pesticides are toxic by design," said Jane Houlihan, former senior vice president of research for EWG. She was not involved in the report.

"They are intended to harm living organisms, and this inherent toxicity has implications for children's health, including potential risk for hormone dysfunction, cancer, and harm to the developing brain and nervous system," said Houlihan, who is now research director for Healthy Babies,

Avoid most pesticides by choosing to eat organic versions of the most contaminated crops, said Alexis Temkin, a toxicologist at the nonprofit Environmental Working Group.

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Bright Futures, an organization dedicated to reducing babies' exposures to neurotoxic chemicals.

Clean 15 option

There is good news, though. Concerned consumers can consider choosing conventionally grown vegetables and fruits from the EWG's Clean 15, a list of crops that tested lowest in pesticides, the report said. Nearly 65% of the foods on the list had no detectable levels of pesticide.

Avocados topped 2023's list of least contaminated produce again this year, followed by sweet corn in second place. Pineapple, onions and papaya, frozen sweet peas, asparagus, honeydew melon, kiwi, cabbage, mushrooms, mangoes, sweet potatoes, watermelon, and carrots made up the rest of the list.

Being exposed to a variety of foods without pesticides is especially important during pregnancy and throughout childhood, experts say. Developing children need the combined nutrients but are also harder hit by contaminants such as pesticides.

"Pesticide exposure during pregnancy may lead to an increased risk of birth defects, low birth weight, and fetal death," the American Academy of Pediatrics noted. "Exposure in childhood has been linked to attention and learning problems, as well as cancer."

The AAP suggests parents and caregivers consult the shopper's guide if they are concerned about their child's exposure to pesticides.

Houlihan, director of Healthy Babies, Bright Futures, agreed: "Every choice to reduce pesticides in the diet is a good choice for a child."

Blueberries and green beans

Nearly 90% of blueberry and green bean samples had concerning findings, the report said.

In 2016, the last time green beans were inspected, samples contained 51 different pesticides, according to the report. The latest round of testing found 84 different pest killers, and 6% of samples tested positive for acephate, an insecticide banned from use in the vegetable in 2011 by the EPA.

"One sample of non-organic green beans had acephate at a level 500 times greater than the limit set by the EPA," said Alexis Temkin, a toxicologist at the EWG with expertise in toxic chemicals and pesticides.

When last tested in 2014, blueberries contained over 50 different pesticides. Testing in 2020 and 2021 found 54 different pesticides — about the same amount. Two insecticides, phosmet and malathion, were found on nearly 10% of blueberry samples, though the levels decreased over the past decade.

Acephate, phosmet and malathion are organophosphates, which interfere with the normal function of the nervous system, according to the US Centers for Disease Control and Prevention.

A high dose of these chemicals can cause difficulty breathing, nausea, a lower heart rate, vomiting, weakness, paralysis and seizures, the CDC said. If exposed over an extended time to smaller amounts, people may "feel tired or weak, irritable, depressed, or forgetful."

Why would levels of some pesticides be higher today than in the past?

"We do see drops in some pesticides since the early '90s when the Food Quality Protection Act was put into place," Temkin said. "But we're also seeing increases of other pesticides that have been substituted in their place which may not be any safer. That's why there's a push towards overall reduction in pesticide use."

Chris Novak, president and CEO of CropLife America, an industry association, told CNN the report "willfully misrepresented" the USDA data.

"Farmers use pesticides to control insects and fungal diseases that threaten the healthfulness and safety of fruits and vegetables," Novak said via email. "Misinformation about pesticides and various growing methods breeds hesitancy and confusion, resulting in many consumers opting to skip fresh produce altogether."

The Institute of Food Technologists, an industry association, told CNN that emphasis should be placed on meeting the legal limits of pesticides established by significant scientific consensus.

"We all agree that the best-case scenario of pesticide residues would be as close to zero as possible and there should be continued science-based efforts to further reduce residual pesticides," said Bryan Hitchcock, IFT's chief science and technology officer.

Switch sources, experts suggest

Many fruits and veggies with higher levels of pesticides are critical to a balanced diet, so don't give them up, experts say. Instead, avoid most pesticides by choosing to eat organic versions of the most contaminated

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crops. While organic foods are not more nutritious, the majority have little to no pesticide residue, Temkin said.

"If a person switches to an organic diet, the levels of pesticides in their urine rapidly decrease," Temkin told CNN. "We see it time and time again."

If organic isn't available or too pricey, "I would definitely recommend peeling and washing thoroughly with water," Temkin said. "Steer away from detergents or other advertised items. Rinsing with water will reduce pesticide levels."

Additional tips on washing produce, provided by the US Food and Drug Administration, include:

- Handwashing with warm water and soap for 20 seconds before and after preparing fresh produce.
- Rinsing produce before peeling, so dirt and bacteria aren't transferred from the knife onto the fruit or vegetable.
- Using a clean vegetable brush to scrub firm produce like apples and melons.
- Drying the produce with a clean cloth or paper towel to further reduce bacteria that may be present.

CNN, 15 March 2023

https://edition.cnn.com

UChicago Scientists Develop New Tool to Protect Artists from AI Mimicry

2023-02-13

Last year, the arrival of powerful AI models capable of generating original images based on text descriptions amazed people with their uncanny ability to simulate different artistic styles. But for artists, that wonder was a nightmare, with the easy, startlingly accurate mimicry threatening their livelihood.

Now, a team of University of Chicago computer scientists have built a tool that protects artists from the absorption of their style into these AI models. Called Glaze, the software "cloaks" images so that models incorrectly learn the unique features that define an artist's style, thwarting subsequent efforts to generate artificial plagiarisms.

[Read a New York Times story about Glaze and the technical and legal battles over generative AI art, and watch Prof. Ben Zhao discuss the work on WTTW's Chicago Tonight.]

The research, developed by the SAND Lab research group led by Neubauer Professors of Computer Science Ben Zhao and Heather Zheng, gives artists a countermeasure against generative art platforms such as DALL-E, Midjourney, and Stable Diffusion, which have exploded in popularity. The team also includes UChicago CS PhD students Jenna Cryan, Shawn Shan, and Emily Wenger and assistant professor Rana Hanocka.

"Artists really need this tool; the emotional impact and financial impact of this technology on them is really quite real," Zhao said. "We talked to teachers who were seeing students drop out of their class because they thought there was no hope for the industry, and professional artists who are seeing their style ripped off left and right."

In 2020, SAND Lab developed Fawkes, an algorithm for cloaking personal photographs so that they could not be used to train facial recognition models. The research was covered by the New York Times and dozens of international outlets, and the software received nearly one million downloads. So when DALL-E and similar applications broke out last fall, SAND Lab started receiving messages from artists hoping that Fawkes could be used to protect their work.

However, merely adapting Fawkes for artistic images proved insufficient. Faces have a small number of features, such as eye color or nose shape, that models use to make their identifications, and slightly perturbing

Scientists from SAND Lab built a tool called Glaze that protects artists from the absorption of their style into generative AI models.

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these features is an effective protection. But an artist's style can be defined by a large number of characteristics, such as brushstroke, color palette, shadowing, or texture. To effectively cloak an artist's work, the most important features that make up their unique style would have to be determined.

"We don't need to change all the information in the picture to protect artists, we only need to change the style features," Shan said. "So we had to devise a way where you basically separate out the stylistic features from the image from the object, and only try to disrupt the style feature using the cloak."

As a solution, the researchers hit upon the clever idea of using AI against itself. "Style transfer" algorithms, a close relative of generative art models, take an existing image – a portrait, a still life, or a landscape – and recreate it in a particular mode, such as cubism, watercolor, or in the style of well-known artists such as Rembrandt or Van Gogh, without changing the content.

Glaze works by running this process on original art, identifying the specific features that change when the image is transformed into another style. Then it returns to the source and perturbs those features just enough to fool art-mimicking AI models, while leaving the original art almost unchanged to the naked eye.

"We're letting the model teach us which portions of an image pertain the most to style, and then we're using that information to come back to attack the model and mislead it into recognizing a different style from what the art actually uses," Zhao said.

When generative art AI systems were fed with the cloaked images, then asked to produce new images in the artist's style, it returned much less successful forgeries with a style somewhere between the original and the style transfer target. Even when the model was trained on a combination of cloaked and uncloaked images, its mimicry was far less accurate on new prompts.

That's good news for artists concerned that AI models have already learned enough from their previously published work to conduct accurate forgeries. Because these models must constantly scrape websites for new data, an increase in cloaked images will eventually poison their ability to recreate an artist's style, Zhao said. The researchers are working on a downloadable version of the software that will allow artists to cloak images in minutes on a home computer before posting their work online.

The research team collaborated with artists at each step of Glaze development, first surveying over 1,000 professional and part-time artists on their concerns about AI art and how it would affect their career and willingness to post their art online. Glaze was tested on the work of four currently-working artists (as well as 195 historical artists), and a focus group of artists evaluated the software's performance in disrupting AI mimicry. After viewing the results of Glaze cloaking, over 90 percent of artists said they were willing to use the software when posting their work.

"A majority of the artists we talked to had already taken actions against these models," Shan said. "They started to take down their art or to only upload low resolution images, and these measures are bad for their career because that's how they get jobs. With Glaze, the more you perturb the image, the better the protection. And when we asked artists what they were comfortable with, quite a few chose the highest level. They're willing to tolerate large perturbations because of the devastating consequences if their styles are stolen."

A preprint of the paper, "Protecting Artists from Style Mimicry by Text-to-Image Models," is available now on arXiv, and you can read more about the project at the SANDLab website.

University of Chicago, 13 February 2023

https://cs.uchicago.edu

Regenerating bone with deer antler stem cells

2023-03-14

Scientists from a collection of Chinese research institutions collaborated on a study of organ regeneration in mammals, finding deer antler blastema progenitor cells are a possible source of conserved regeneration cells in higher vertebrates. Published in the journal Science, the researchers suggest the findings have applications in clinical bone repair. With the activation of key characteristic genes, it could potentially be used in regenerative medicine for skeletal, long bone or limb regeneration.

Limb and organ regeneration is a long coveted technology in medical science. Humans have some limited regenerative abilities, mostly in our livers. If a portion of the liver is removed, the remaining liver will begin to grow until it reaches its original functional size. Lungs, kidneys, and pancreas can do this also, though not as thoroughly or efficiently.

Limb and organ regeneration is a long coveted technology in medical science.

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Compare this to a lizard regenerating a tail, a zebrafish replacing a fin, a lobster regrowing a claw, or an axolotl salamander that can rebuild organs, limbs, spinal cord and even missing brain tissue.

We will not mention the hydra here if only because being able to regenerate itself an entire head after being cut in half (as the other half generates a new body making two hydras) raises too many philosophical questions about the meaning of "self" to tackle here. At least it is beyond the ambitions of current medical researchers considering more modest attempts at human tissue regeneration.

There is one type of mammal that engages in regenerative behavior in a very routine and reliable way, the deer. Male deer antlers regrow yearly as living tissue, with blood vessels and nerves wrapped around a fast growing boney structure. The researchers document a blastema-like structure present during antler regeneration, one similar to the structure involved in amphibian limb regeneration, suggesting a conserved biological feature available to vertebrate tissue regeneration.

There is another mammal with limited ability to regrow parts of a limb—mice. Mice can regenerate the tips of their foretoes. A cross-species comparison found that regenerative progenitor cells similar to those found in the deer antler blastema-like structure are also present in the mouse regenerative foretoe tip but not in nonregenerative mouse toes. These genes were also different from those found in axolotl limbs or zebrafish fins.

According to the study, "This suggests the existence of relatively conserved cellular and molecular mechanisms for the only two known cases of regenerative capacity in mammalian appendage organs."

To fully document the gene transcription dynamics and asses cell type changes during antler regeneration, the research team pursued single-cell RNA sequencing of antlers at different stages of regeneration and a chromosome-level genome assembly of a male sika deer. 74,730 cells covering the critical stages of antler regeneration were analyzed, with some remarkable connections found between cell types reportedly crucial during limb regeneration in frogs and axolotl, as well as digit tip regeneration in mice.

An experiment was performed on mice to test the role of these progenitor cells. In the experiment, antler progenitor cells were introduced to the heads of laboratory mice. Antler-like boney cartilage formations appeared on the skull caps of mice that were not recruited from local tissues but

entirely from the growth of transplanted stem cells, showing that the scientists had successfully isolated the essential cell types for regeneration.

Phys Org, 14 March 2023

https://phys.org

The Toxic Threat in Thawing Permafrost

2023-03-15

Covering nearly the same area as Norway, the Hudson Bay Lowlands in northern Ontario and Manitoba is home to the southernmost continuous expanse of permafrost in North America. Compared with many marine waterways this far south, Hudson Bay stays frozen late into the summer, its ice-covered surface reflecting sunlight and keeping the surrounding area cold.

The influence of Hudson Bay on the weather is crazy, says Adam Kirkwood, a graduate student at Carleton University in Ottawa, Ontario. "It can be sunny and 20 °C one day in August, and then half an hour later there's a wicked wind coming in from the bay—it's 5 °, and you're putting on all your layers, and you're still freezing cold. And when it's neither of those two things," he says, "it's very, very buggy."

Trapped in all that permafrost is 30 billion tonnes of carbon. It's an unfathomable amount, says Kirkwood. With global warming, the permafrost is thawing, threatening to release a "carbon bomb" of heat-trapping methane gas to the atmosphere. But there's something else lurking in the permafrost, too. Something that has the potential to be more immediately dangerous to the people and wildlife living in the area: mercury.

Wildfires and volcanoes belch mercury and since the Industrial Revolution so, too, do coal-burning power plants and factories. Warm air currents carry mercury in its inorganic heavy metal form to the Arctic where it settles into the soil and vegetation before being safely locked away in the deeply frozen permafrost.

In its inorganic form, mercury is less threatening to people. But as the permafrost thaws, says Kirkwood, mercury is finding its way into the soil and into the regions' many ponds, rivers, and lakes. Once there, microbes can convert inorganic mercury into the form to be concerned about: neurotoxic methylmercury.

Scientists are tracking neurotoxic methyl-mercury production in North America's largest peatland.

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For the Indigenous peoples of northern Ontario who have lived off the peatlands for thousands of years—hunting caribou, catching fish, and gathering native plants—the lurking threat poses a risk to their way of life.

So for the past six years, Kirkwood has been coming to this remote environment every summer, helicoptering in to drill thick cores of peat and bringing them back to his lab for analysis. On these trips, Kirkwood often has help from Sam Hunter, a self-taught independent scientist from Peawanuck, Ontario.

Back in the 1970s, Hunter saw how scientists studying the Hudson Bay Lowlands used Indigenous peoples as guides, but didn't involve them in their research. Now, he says, there's a co-management process—he accompanies researchers on their fieldwork and helps bring their findings back to local communities. Bringing together outside scientists and traditional knowledge is important, he says, because Indigenous peoples have seen firsthand how the permafrost is changing.

"Walking on permafrost is like walking on really hard ground, like gravel," says Hunter. When there's permafrost, he says, "there's all kinds of flora. There's berries, vegetation that animals feed on. We collect wild tea."

But once the permafrost thaws, he says, "the environment turns into a swampland. … You can't even walk, you'd sink." Along with the disappearing permafrost "go the animals. They move higher and higher into the Arctic. Muskox has disappeared and a few shorebirds we used to have—they're moving north."

Methylmercury seeping out of the permafrost is the latest water-quality issue First Nations communities in the region have faced. Closer to the Manitoba border, industrial mercury pollution from the 1960s still affects 90 percent of the Anishinaabe community Grassy Narrows. Many First Nations communities across Canada still lack clean drinking water. In the absence of government support for water-quality testing, Hunter has trained three community members in Peawanuck to test their water and fish.

Whether all of the mercury idling in the permafrost will become a significant threat to locals hinges on the answers to a few outstanding questions—questions Kirkwood aims to answer.

A decade ago, scientists discovered that certain microbes with a specific gene can convert inorganic mercury into toxic methylmercury. Scientists know some microbes have this ability and others don't, but efforts to

relate the abundance of microbes with mercury methylating potential to the amount of methylmercury in the environment have been unsuccessful. That's led scientists studying mercury cycling, like Andrea Bravo at the Institute of Marine Sciences in Spain, to theorize that there's more at play dictating the pace of methylmercury production, like the complex relationships between the entire community of microbes in the soil.

That's where Kirkwood's research comes in. By drilling and taking core samples of the permafrost, then measuring the amount of inorganic mercury while at the same time sequencing the DNA of everything in the soil, he hopes to better understand how methylmercury gets produced in thawing permafrost. Once he knows that, he can figure out where the threat is largest by looking at where mercury methylating microbes and inorganic mercury overlap.

"It's a hot topic, a timely research question," says Bravo, who isn't involved in Kirkwood's research. "We are suddenly having a surface of soil that was not reactive before, and it's becoming reactive. … We don't know how much mercury is coming from this permafrost."

Bravo points out there are still many unknowns in efforts to gauge the mercury threat. For one, it's still not yet possible to accurately predict methylmercury levels in freshwater waterways or the ocean based on land sources. Despite global research efforts, "we still don't understand the process completely," she says. "We've put in a lot of effort, but we aren't there yet."

So far, Kirkwood's initial findings show reason for hope. Previous Arctic-scale estimates of inorganic mercury abundance have vastly overestimated how much mercury is being stored in the Hudson Bay Lowlands. Kirkwood's cores show mercury levels 10 times lower. But that doesn't mean all is well. In thermokarst fens, meltwater ponds created when iceberg-like permafrost chunks thaw, methylmercury levels are higher than in the surroundings. As more permafrost thaws and these ponds connect, methylmercury production will likely increase. And if this mercury reaches the bay, biomagnification could cause it to build up to high concentrations, making its way up the food chain from algae to the tissue of fish that people catch and eat.

One of the things Hunter says he's been told by the scientists who come up from the south is that the polar bear is the barometer for climate change. "And I don't agree with that. I think the barometer for climate

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change is the palsa, the melting permafrost," he says. "And I think that we need to understand what's coming out of the ground now."

Hakai Magazine, 15 March 2023

https://hakaimagazine.com

Teeth track gender bias back over 1,000 years

2023-03-16

The findings—published in the Proceedings of the National Academy of Sciences—highlight why gender norms have remained stubbornly persistent in many parts of the world despite significant strides made by the international women's rights movement over the last 100-150 years.

Using dental records of more than 10,000 people from 139 archaeological sites throughout Europe, researchers found that individuals who live in areas that historically favored men over women display more pro-male bias today than those who live in places where gender relations were more egalitarian centuries ago—evidence that gender attitudes are "transmitted" or handed down from generation to generation.

These biases outlasted monumental socioeconomic and political changes such as industrialization and world wars. Researchers found one exception to the rule, however: In regions that experienced abrupt, large-scale population replacement—such as a pandemic or natural disaster—transmission of these values was interrupted.

"The median age of the skeletons in this study is about 1,000 years dating back to the medieval era. It is therefore remarkable that the patterns of gender bias that existed during those times and earlier are still replicated in contemporary attitudes," says Margit Tavits, professor at Washington University in St. Louis.

"Given the enormous social, economic, and political changes that have taken place in Europe during this time, our findings speak to the power of cultural transmission of gender norms."

The incredible stability of these norms over hundreds, if not thousands, of years also explains why it has been difficult in some regions to move the needle toward gender equality.

"There has been a widespread belief that gender norms are a byproduct of structural and institutional factors like religion and agricultural practices. Our findings draw attention to the fact that gender-equal norms passed

Modern gender norms and biases in Europe have deep historical roots dating back to the Middle Ages and beyond, research finds.

down from one generation to the next can persist even if institutions or structures incentivize inequality, and vice versa," Tavits says.

"For those working to foster gender equality, the message from our research is that rules and policies are not going to be enough to undermine deeply rooted sexist beliefs and sustain equal ones. We must also address the cultural forces channeling these beliefs."

Taylor Damann and Jeremy Siow, doctoral students in the department of political science, conducted research and coauthored the paper with Tavits.

What do teeth show about gender bias?

Previous archaeological research has used linear enamel hypoplasias—permanent lesions on the teeth caused by trauma, malnutrition, or disease—to analyze prehistoric gender equality. Because the lesions form exclusively in cases of sustained bodily stress, their presence or absence can tell researchers a great deal about the person's health and living conditions. Further, differences between male and female teeth at the same location are an indication of which sex received preferential treatment in terms of health care and dietary resources at the time.

The present study is the first of its kind to connect these measures to contemporary attitudes.

According to Tavits, studying gender norms in Europe is advantageous given the relative similarity of various institutional and environmental conditions across the region. This allowed researchers to control for factors that could affect modern gender attitudes, such as religion and political institutions.

Because differences in gender attitudes are fairly small across the continent, compared with the rest of the world, this setting also set a higher bar for detecting significant associations between historical and contemporary attitudes. Yet, time and time again, researchers found evidence of this association. For example, individuals living in an area that was historically egalitarian were 20% more likely to have pro-female attitudes than people living in areas that were historically the most pro-male.

Additional tests showed that historical gender bias failed to predict modern gender attitudes for immigrant populations. Researchers also found no evidence of historical gender bias affecting contemporary attitudes in areas hardest hit by the bubonic plague of the 14th century.

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Finally, they looked to the United States, where the arrival of European settlers in the 16th century led to large-scale displacement of Native Americans. Once again, they found no association between historical and current gender norms.

"Together, these findings provide further support for the idea that historical biases persist because they are passed down from one generation to the next and occur only when the transmission across generations is not interrupted. We were surprised that such a clear relationship emerged," Tavits says.

Ancient and modern attitudes

In the paper, Tavits, Damann, and Siow highlight two archaeological sites to illustrate how the contrasting historical treatment of women relative to men is reflected in current gender attitudes.

At the first site in Istria, a small urban Greek settlement on the Black Sea in the modern Dobruja region of Romania, researchers found evidence of a pro-male bias in historical dental records dating back to around 550 CE. Out of the 49 skeletons for whom sex and dental information could be extracted, 58% of females show signs of malnutrition and trauma in their teeth, while only 25% of males do.

According to the authors, the status of men and women in society today has remained relatively unequal in the southeastern region of Romania, based on modern indicators of gender equality. For example, they note, only 52.5% of women participate in the labor market compared with 78% of men, and only 18% of the representatives in the modern municipal council are women.

The population's beliefs about gender norms are similarly unequal, they write. More than half of the residents believe that men have more of a right to jobs than women and there is near consensus (89%) that a woman must have children to be fulfilled.

Contrast this with Plinkaigalis, a rural community in modern-day western Lithuania made up of a population of Balts. Unlike Istria, Plinkaigalis favored women's health. Of the 157 skeletons at this site—also dating back to 550 CE—56% of males show dental signals of trauma and malnutrition whereas only 46% of females do. Separate studies have also found evidence that gender norms here were favorable to women.

In the modern era, this location, now called Kėdainiai, remains relatively gender equal. Employment levels in western Lithuanian do not vary

strongly by gender: 76% men vs. 72.7% women. And women are nearly proportionally represented in local politics (48%). Likewise, less than a quarter of residents of the modern location believe men have more of a right to a job than women, and 56% believe women need children to be fulfilled.

"In sum, the parallels between historical and modern gender norms at both of these locations are stark and in line with our argument about persistence," the authors write. "The male preference at Istria, dating back at least to the early medieval era, is still reflected in unequal gender relations today.

"The area around pre-medieval Plinkaigalis, on the other hand, continues to treat men and women with relative equality as (according to skeletal records) it did about 1,500 years ago."

Futurity, 16 March 2023

https://futurity.org

How stem cells make a human brain

2023-03-16

In a technical "tour de force", researchers have analysed multiple traits of individual cells to pinpoint those that give rise to crucial components of the human brain.

The analysis, published on 16 March in Cell1, uses a combination of protein and RNA analysis to painstakingly purify and classify individual stem cells and their close relatives isolated from human brains. Researchers then injected different types of cell into mice and monitored the cells as they divided and their progeny took on specialized roles in the brain.

The hope is that this study, and others like it, will illuminate how such developmental programmes go awry in neurological diseases — and how they can be harnessed to create new therapies. "The census of stem and progenitor cells in the developing human brain is really just beginning," says Arnold Kriegstein, a developmental neuroscientist at the University of California, San Francisco, who was not involved in the research. "This work offers a nice window into some of that complexity."

Cellular ensemble

The brain is an intricate symphony of different cells, each of which performs essential functions. Star-shaped cells known as astrocytes,

Technical "tour de force" allows researchers to trace the family tree of crucial brain cells.

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for example, are important for supporting metabolism in neurons, and loss of astrocyte function is linked to neurodegenerative conditions such as Alzheimer's disease. Oligodendrocytes are cells that create a protective, insulating sheath around the connections between neurons. When they are damaged — as in diseases such as multiple sclerosis — communication between neurons slows or stops altogether.

To understand how such cells arise, stem cell biologists Irving Weissman and Daniel Liu and their colleauges at Stanford University in California harnessed new technology that would allow them to study the developmental destiny of individual cells taken from human brains.

The team isolated brain cells from human fetuses that were 17–19 weeks old and tested the cells for a battery of 11 proteins on the cell surface, including six that are associated with neural cell development. They also analysed RNA levels as a measure of gene activity and used this information to purify 10 kinds of cell that are likely to give rise to astrocytes, oligodendrocytes and neurons.

The researchers then injected the purified cells into mouse brains. Six months later, they analysed those mice to find out where the cells and their descendants had migrated, and what cellular identities they had taken.

The approach enabled the team to define a new kind of progenitor cell that gives rise to glial cells, a grouping that includes astrocytes and oligodendrocytes (see 'How to make a brain'). These progenitors are derived from cells that are more sparse in mouse brains than in human brains, says Liu. "We think that this cell type might be important for specific adaptations that primate brains have made," he says.

The team also found that high levels of a protein called Thy1 are associated with cells in the oligodendrocyte lineage. This runs counter to previous findings, which suggested that Thy1 was a marker for neurons rather than oligodendrocytes, says Steven Goldman, a neurologist at the University of Rochester Medical Center in New York and head of central nervous system therapy at Sana Biotechnology in Cambridge, Massachusetts.

Such differences could also be the result of the new approach's improved resolution of different cell types, Goldman says, adding that the work is "a technical tour de force. … They upped the level of the field." Weissman says that the technique might be useful for studying other kinds of stem cell as well.

Complex brew for a brain

The study is an important contribution to the growing knowledge of the cellular lineages that give rise to the human brain, agrees Kriegstein. But he notes that the development of human stem cells in mice might not fully reflect how the cells would develop in human brains.

Goldman worries that the lineages derived by the analysis do not reflect the plasticity of neural cell development. Other research has found that some cells in the brain can begin down one lineage, only to change paths and emerge as an unrelated neural cell, he says. Liu and Weissman think that some of that apparent plasticity was instead an artefact of studying mixtures of cells, and might not be as pronounced when using the stringent selection criteria for purifying cells that they developed.

But Goldman suspects that other factors influence how committed neural cells remain to their lineage. "The nervous system is more complicated in terms of diversification," says Goldman. "There's still a lot to learn."

Nature, 16 March 2023

https://nature.com

Wonder enzyme may hold the key to longer, healthier lives

2023-03-14

Could an enzyme responsible for breaking down and eliminating booze from our bodies also be able to help us lead longer, healthier lives? Scientists have discovered a molecular mechanism that could offer just that.

In a surprise finding, researchers at the University of Virginia (UVA) found that the role of alcohol dehydrogenase in detoxifying the body of glycerol and glyceraldehyde – the harmful by-products of fat that build up over time – may provide the best approach to not just extending life but aging more healthily.

"The discovery was unexpected," said Eyleen Jorgelina O'Rourke, Associate Professor at UVA's Department of Biology and the UVA School of Medicine's Department of Cell Biology. "We went after a very well-supported hypothesis that the secret to longevity was the activation of a cell-rejuvenating process named autophagy and ended up finding an unrecognized mechanism of health and lifespan extension."

Could an enzyme responsible for breaking down and eliminating booze from our bodies also be able to help us lead longer, healthier lives?

Naming the mechanism AMAR (alcohol or aldehyde mediated anti-aging response), which is also the Sanskrit word for immortality, the scientists saw surprising responses by activating the adh-1 gene. It resulted in the gene producing more of the alcohol dehydrogenase enzymes, blocking the toxicity caused by glycerol and, indirectly, glyceraldehyde.

In Caenorhabditis elegans, activating this AMAR mechanism showed the microscopic worms not only lived 50% longer but had better health signs, too.

C. elegans are the preferred model for aging studies; the microscopic soil-dwelling worms' two-to-three-week lifespan offers scientists measurable results, and they share more than 70% of our genetic makeup. Previously scientists have extended their lifespan by blocking a particular enzyme, seen positive results with a cocktail of drugs, explored the gut-brain relationship with aging, and used them to look at why immortality is so elusive.

The team then found that the anti-aging mechanism had a similar benefit on another lab subject, yeast. They then looked at studies on others, including humans, that had undergone fasting or calorie restriction, both understood to play a role in living longer and healthier.

"Another exciting moment was when we mined the gene activities of calorically restricted mice, pigs, Rhesus monkeys, and humans, and saw that their adh-1 was activated," O'Rourke told New Atlas.

Scientists suspect that because glycerol and glyceraldehyde are toxic, health-draining by-products of fat, and that we store more as we age, they could be contributing factors in us experiencing more health issues over time. AMAR may combat and break down the build-up of the harmful by-products, leading to more years of good health. What's more, the activation of adh-1 showed an ability to counter weight gain and even promote weight loss.

"In fact, we see this response across species from yeast to high plants and humans," O'Rourke told New Atlas. "Activating adh-1 promotes leanness, even when animals are eating as much as they want."

The team expects to now test if genetic activation of the enzyme extends the lifespan of mice, and then conduct in vitro research with human cultured cells to examine if activation of adh-1 reduces or delays the cellular markers of aging.

"We are hoping to identify partners (academic or private) to search together for compounds that activate the alcohol and/or the aldehyde dehydrogenase," she told New Atlas. "We are eager to perform these searches for activators because we see that the activation of these enzymes not only extends lifespan but it also reduces the severity and delays the onset of age-related diseases including obesity, loss of muscle function, and neurodegeneration."

The study was published in the journal Current Biology.

New Atlas, 14 March 2023

https://newatlas.com

How do we smell? First 3D structure of human odour receptor offers clues

2023-03-16

It is thanks to proteins in the nose called odour receptors that we find the smell of roses pleasant and that of rotting food foul. But little is known about how these receptors detect molecules and translate them into scents.

Now, for the first time, researchers have mapped the precise 3D structure of a human odour receptor, taking a step forwards in understanding the most enigmatic of our senses.

The study, published in Nature on 15 March1, describes an olfactory receptor called OR51E2 and shows how it 'recognizes' the smell of cheese through specific molecular interactions that switch the receptor on.

"It's basically our first picture of any odour molecule interacting with one of our odour receptors," says study co-author Aashish Manglik, a pharmaceutical chemist at the University of California, San Francisco.

Smell mystery

The human genome contains genes encoding 400 olfactory receptors that can detect many odours. Mammalian odour-receptor genes were first discovered in rats by molecular biologist Richard Axel and biologist Linda Buck in 19912. Researchers in the 1920s estimated that the human nose could discern around 10,000 smells3, but a 2014 study suggests that we can distinguish more than one trillion scents4.

Finding could advance our understanding of how human olfactory proteins recognize specific scents, including the pong of ripe cheese.

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Each olfactory receptor can interact with only a subset of smelly molecules called odorants — and a single odorant can activate multiple receptors. It is "like hitting a chord on a piano", says Manglik. "Instead of hitting a single note, it's a combination of keys that are hit that gives rise to the perception of a distinct odour."

Beyond this, little is known about exactly how olfactory receptors recognize specific odorants and encode different smells in the brain.

Technical challenges in producing mammalian olfactory-receptor proteins using standard laboratory methods have made it difficult to study how these receptors bind to odorants.

"Almost all of them really don't like being in any other kind of cell other than an olfactory sensory neuron," says Matthew Grubb, a neuroscientist at King's College London. This means that they cannot be grown or stabilized in commonly used cell lines. "You would have to dissect probably thousands of mice noses" to replicate samples, says Grubb. "It's just not feasible."

To overcome this, Manglik and his colleagues focused on the OR51E2 receptor, which has functions beyond odorant recognition and is found in gut, kidney and prostate tissues, as well as olfactory neurons.

Vinegar and cheese

OR51E2 interacts with two odorant molecules: acetate, which smells like vinegar, and propionate, which has a cheesy odour.

The authors purified the receptor and analysed the structure of propionate-bound and unbound OR51E2 using cryo-electron microscopy, an atomic-resolution imaging technique. They also used computer-aided simulations to model how the protein interacts with the odorant at an atomic scale.

They found that propionate binds OR51E2 through specific ionic and hydrogen bonds that anchor the propionate's carboxylic acid to an amino acid, arginine, in a region of the receptor called the binding pocket. Binding to propionate alters the shape of OR51E2, which is what turns the receptor on.

These molecular interactions are crucial: the researchers showed that mutations affecting arginine prevented OR51E2 from being activated by propionate.

"This is our way of kind of lining up the dominoes to understand how pushing on one side of the receptor turns the other side on," says Manglik.

On the scent

Scientists have long dreamed of building a molecular atlas of olfactory receptors that maps their chemical structures and which combinations of receptors correspond to particular odours. But "that's been very much out of reach for the field", says Manglik.

The OR51E2 receptor is specific to propionate and acetate. But "it's not all about single odorant binding to single receptor molecules", says Grubb. OR51E2 is a class I olfactory receptor; only around 10% of human olfactory-receptor genes encode this type. The rest code for class II receptors, which typically recognize a broader range of odours. "They may have very different mechanisms," says Vanessa Ruta, a neuroscientist at the Rockefeller University in New York City.

Studying other examples of human odour receptors and elucidating their structures is crucial, she adds. "It will allow for a broader understanding of the different ways that odorants are recognized."

Nature, 16 March 2023

https://nature.com

Scientists make 'disturbing' find on remote island: plastic rocks

2023-03-21

There are few places on Earth as isolated as Trindade island, a volcanic outcrop a three- to four-day boat trip off the coast of Brazil.

So geologist Fernanda Avelar Santos was startled to find an unsettling sign of human impact on the otherwise untouched landscape: rocks formed from the glut of plastic pollution floating in the ocean.

Santos first found the plastic rocks in 2019, when she traveled to the island to research her doctoral thesis on a completely different topic—landslides, erosion and other "geological risks."

She was working near a protected nature reserve known as Turtle Beach, the world's largest breeding ground for the endangered green turtle, when she came across a large outcrop of the peculiar-looking blue-green rocks.

"Marine pollution is provoking a paradigm shift for concepts of rock and sedimentary deposit formations."

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Intrigued, she took some back to her lab after her two-month expedition.

Analyzing them, she and her team identified the specimens as a new kind of geological formation, merging the materials and processes the Earth has used to form rocks for billions of years with a new ingredient: plastic trash.

"We concluded that human beings are now acting as a geological agent, influencing processes that were previously completely natural, like rock formation," she told AFP.

"It fits in with the idea of the Anthropocene, which scientists are talking about a lot these days: the geological era of human beings influencing the planet's natural processes. This type of rock-like plastic will be preserved in the geological record and mark the Anthropocene."

Island paradise

The finding left her "disturbed" and "upset," said Santos, a professor at the Federal University of Parana, in southern Brazil.

She describes Trindade as "like paradise": a beautiful tropical island whose remoteness has made it a refuge for all sorts of species—sea birds, fish found only there, nearly extinct crabs, the green turtle.

The only human presence on the South Atlantic island is a small Brazilian military base and a scientific research center.

"It's marvelous," she said.

"So it was all the more horrifying to find something like this—and on one of the most ecologically important beaches."

She returned to the island late last year to collect more specimens and dig deeper into the phenomenon.

Continuing her research, she found similar rock-like plastic formations had previously been reported in places including Hawaii, Britain, Italy and Japan since 2014.

But Trindade island is the remotest place on the planet they have been found so far, she said.

She fears that as the rocks erode, they will leach microplastics into the environment and further contaminate the island's food chain.

'Paradigm shift'

She and her team's study, published in September in the journal Marine Pollution Bulletin, classified the new kind of "rocks" found worldwide into several types: "plastiglomerates," similar to sedimentary rocks; "pyroplastics," similar to clastic rocks; and a previously unidentified type, "plastistones," similar to igneous rocks formed by lava flow.

"Marine pollution is provoking a paradigm shift for concepts of rock and sedimentary deposit formations," her team wrote.

"Human interventions are now so pervasive that one has to question what is truly natural."

The main ingredient in the rocks Santos discovered was remnants of fishing nets, they found.

But ocean currents have also swept an abundance of bottles, household waste and other plastic trash from around the world to the island, she said.

Santos said she plans to make the topic her main research focus.

Trindade "is the most pristine place I've ever seen," she said.

"Seeing how vulnerable it is to the trash contaminating our oceans shows how pervasive the problem is worldwide."

Phys Org, 21 March 2023

https://phys.org

Moooove over: How single-celled yeasts are doing the work of 1,500-pound cows

2023-03-12

The first course was a celery root soup lush with whole milk. The last was a spice cake topped with maple cream cheese frosting, served with a side of ice cream. And then a latte with its fat cap of glossy foam. In all, a delicious lunch. Maybe a little heavy on the dairy.

Only this dairy was different. It was not the product of a cow or soybean or nut. The main ingredient of this milk was made by microbes in a lab, turned into tasty and recognizable food, and then served to a hungry reporter.

Dozens of companies have sprouted up in recent months to develop milk proteins made by yeasts or fungi, including Perfect Day, the California-based dairy company that laid out this unusual spread. The companies'

Cowless dairy is here, with the potential to shake up the future of animal dairy and plant-based milks

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products are already on store shelves in the form of yogurt, cheese and ice cream, often labeled "animal-free." The burgeoning industry, which calls itself "precision fermentation," has its own trade organization, and big-name food manufacturers such as Nestlé, Starbucks and General Mills have already signed on as customers.

The rapid advancement in this area has sparked hope for a revolution in the dairy industry, and not just because it's kinder to the cows. Precision dairy doesn't have cholesterol, lactose, growth hormones or antibiotics (though those with dairy allergies should beware). And cattle, for beef or dairy, is said to be the No. 1 agricultural source of greenhouse gases worldwide. Consumers concerned about climate change or animal welfare have been anticipating the U.S. launch of cultivated meat, which is grown in labs from animal cells, but cultivated dairy could have just as much of an impact on the environment — with fewer regulatory hurdles to clear.

Despite widespread acceptance of soy, oat and almond milk, U.S. consumers, even vegan ones, continue to be underwhelmed by plant-based cheese options: Mostly made of starch and oil, they often lack the flavor or texture (no gooey strings, not enough bounce) of real cheese. And cheese is especially bothersome for the environment, more so than its liquid counterpart: Making one pound of cheese requires 10 pounds (or about five quarts) of cow's milk. The World Economic Forum and many scientific reports suggest cheese generates the third-highest emissions in agriculture after beef and lamb.

Biden's climate change plan may not nix cheeseburgers, but science says beef should be on the chopping block

For Ryan Pandya, chief executive of Perfect Day, those are the problems he's solving. But it really started as a bagel problem.

Studying chemistry and bioengineering at Tufts, he'd gone vegetarian but still had a craving and taste for animal products.

"I had a bagel with vegan cream cheese that was so bad that it led me to investigate. What's so hard about this? A lot of dairy alternatives are not made of food," he said with a wince.

He hit upon a process called precision fermentation, similar to what has been used for decades to brew beer, make insulin for diabetic patients or produce rennet for cheese.

"Rather than using 22nd-century technology to produce meat, we're using 20th-century technology to produce milk protein," he said.

There are bubbling stainless steel fermentation tanks, software that maintains temperatures, agitator motors and oxygenators. And after the microbes eat their sugar solution and are programmed to make the desired proteins, there's a lengthy process to separate the milk protein from the medium, then to wash it and dry it in a spray dryer so the powder can be used to make food.

Beyond the fermentation process, making usable milk proteins is similar to that at regular cow dairies, which have stainless steel tanks, spray dryers and freeze dryers, pasteurizers and vacuum pumps, chillers and steamers. "We get to the same powder, but these are the cows," said Irina Gerry, chief marketing officer at Change Foods in Palo Alto, Calif., pointing to the fermenters in their San Jose lab.

The world's demand for dairy keeps going up. But it's not necessarily liquid milk. As countries develop and have burgeoning middle classes, the demand for liquid milk drops and enthusiasm for cheese and other products skyrockets. The cheese category has grown 19 percent since 2017, according to Mintel's Future of Cheese 2022 report, with plant-based versions making up a minuscule part of that market.

General Mills, which produces household brands like Betty Crocker, Pillsbury, Annie's, Nature Valley and Häagen-Dazs, launched a series of Bold Cultr cream cheeses, first using precision-dairy milk proteins from Perfect Day, then from Israeli foodtech start-up Remilk. (Last month, General Mills said it was "deprioritizing funding" for these cream cheeses, so its future is uncertain.) Perfect Day's ingredients are being used in Brave Robot ice cream in the United States, Modern Kitchen cream cheese in the United States, California Performance Co. protein powder in the United States, Singapore and Hong Kong; and Coolhaus ice cream products in the United States and Singapore.

Perfect Day, the first to market in the United States, is also partnering with Mars, Nestlé, Starbucks, Graeter's and other companies to provide milk protein for products. Its office is a gleaming, multistory facility in an industrial part of Berkeley, Calif. that has become a locus for food and biotech start-ups. It has fermentation and separations teams, analytics and regulatory experts, legal and logistics teams, as well as two full-time chefs to prototype products and dishes in a sleek exhibition kitchen. In addition to its Berkeley facility, the company operates a 90,000-square-foot production facility in Bangalore, India and a 58,000-square-foot factory in Salt Lake City.

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Change Foods, founded in 2020, is headquartered in both Australia and the United States, and is in the process of building a commercial manufacturing plant in Abu Dhabi that will produce the volume of animal-free milk protein casein equivalent to the output of 10,000 dairy cows. Like Perfect Day, it aims to be an ingredient company that supplies its milk protein to other established food companies, but it will launch its own branded cheese products in 2025.

Precision fermentation dairy's growth has to happen fast to be price-competitive with traditional animal dairy and to gain widespread adoption, said Ravi Jhala, Perfect Day's global head of commercial. Recent declines in plant-based meat sales are a cautionary tale.

Part of the reason analysts see a bright future for precision dairy is the desire by mainstream food companies to reduce their carbon footprint. Many have trumpeted their sustainability goals, often making promises like having net-zero carbon emissions by 2030, or 2040, or beyond. To get there, they are turning to companies like Perfect Day, which is collaborating with Mars to develop a more eco-friendly chocolate bar.

But will customers buy it? It is delicious? Most of the 28 precision dairy companies gearing up globally are selling their milk proteins as ingredients to other food companies, so the finished products are only as good as the food companies making them. One company's plain cream cheese may be creamy and indistinguishable from a cow-based one, but another company might decide to solve too many problems simultaneously: Animal-free, sugar-free, fat-free, all-natural and low-calorie. That could be a recipe for a sad schmear or pint, something that could turn shoppers off to the whole category.

Consumers are loyal to brands, not ingredients, experts say. And brands get to decide what their messaging is to consumers. That General Mills cream cheese? It's marketed as a "lactose-free, non-animal cream cheese alternative." Mars describes its new chocolate as a silky smooth chocolate (not an "alternative" to chocolate) that uses "real dairy protein …. without any inputs from animals." Brave Robot ice cream leans heavier on the sustainability and cruelty-free aspects. So even the messaging around precision dairy could be confusing.

"Nestlé and Mars, they have the reach and the customers. They could position these new products as extensions of existing product lines, but the jury is still out on what the labels will say," said Tony Moses, who is in product innovation for CRB, a consulting and manufacturing company for the food and beverage industries.

Traditional cow dairy has pushed back against plant-based milks using words like "milk" or "cheese" in a series of largely unsuccessful lawsuits. At the end of February, the FDA announced that oat, soy and almond drinks can keep the word "milk" in their names, but squabbles around precise language will likely recur when more of these precision dairy products reach the market.

The International Dairy Foods Association opposes any explicit or implicit use of the term "dairy" for precision products without qualification in their marketing and merchandising, said spokesman Matt Herrick.

"Our position is that FDA must develop a uniform, mandated disclosure approach to this technology to ensure labeling is truthful and not misleading for consumers," he said.

Development of these products comes at a time when there's huge interest in finding alternative protein sources to feed a skyrocketing global population more sustainably. Still, for an industry in its infancy, the way forward could have significant roadblocks.

The dairy industry, with its clout and hefty lobbying budget, may not agree there is room for everyone: In 2022, U.S. cow dairy had ceded 16 percent of all retail milk sales to plant-based milk, according to data from SPINS and the Plant Based Foods Association.

Plant-based milk companies also may not welcome the competition, especially if cultivated dairy products are positioned as more sustainable and less resource-intensive. (A glass of almond milk takes 23 gallons of water to produce, according to the nonprofit Water Footprint Network.)

The industry is also likely to run up against Americans' increasing discomfort with processed food. The cow dairy industry and plant-based companies could team up to paint these newcomers as Franken-foods made by mad scientists in a lab.

And the regulatory path ahead is not assured for this fledgling industry. As a comparison, CBD-infused food and drink products burst onto the scene a few years ago as more states decriminalized marijuana and hemp. But after deliberation, in January, the FDA refused to regulate it and asked Congress to step in. For now, it's still illegal, and CBD food companies are in limbo.

For many of these venture capital-funded start-ups, any of these hiccups could mean the difference between success and failure.

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Stakes are high: TurtleTree in Sacramento and Biomilq in Durham, N.C., are both focused on using this technology to produce human breast milk or its components. Last year's infant formula crisis made it clear that finding enough nutritionally appropriate alternatives to breast milk is a national food security imperative.

In a way, lab-grown cultivated meat may have cast its looming shadow over this new dairy technology, leaving it shrouded in mystery.

"This is an industry that jumped to the market way faster than I thought it would, and part of that is the regulatory hurdles," Moses said. "Great things are happening in the lab, but it's that getting to market, that commercialization piece, that is less certain. I'm watching what Perfect Day is doing. How did this get here without us knowing?"

Washington Post, 12 March 2023

https://washingtonpost.com

Material heralds new 'dawn' for superconductivity

2023-03-13

"With this material, the dawn of ambient superconductivity and applied technologies has arrived," according to a team led by Ranga Dias, an assistant professor of mechanical engineering and of physics at the University of Rochester.

In a paper in Nature, the researchers describe a nitrogen-doped lutetium hydride (NDLH) that exhibits superconductivity at 69 degrees Fahrenheit and 10 kilobars (145,000 pounds per square inch, or psi) of pressure.

Although 145,000 psi might still seem extraordinarily high (pressure at sea level is about 15 psi), strain engineering techniques routinely used in chip manufacturing, for example, incorporate materials held together by internal chemical pressures that are even higher.

Scientists have been pursuing this breakthrough in condensed matter physics for more than a century. Superconducting materials have two key properties: electrical resistance vanishes, and the magnetic fields that are expelled pass around the superconducting material. Such materials could enable:

- Power grids that transmit electricity without the loss of up to 200 million megawatt hours (MWh) of the energy that now occurs due to resistance in the wires

In a historic achievement, researchers have created a superconducting material at both a temperature and pressure low enough for practical applications.

- Frictionless, levitating high-speed trains
- More affordable medical imaging and scanning techniques such as MRI and magnetocardiography
- Faster, more efficient electronics for digital logic and memory device technology
- Tokamak machines that use magnetic fields to confine plasmas to achieve fusion as a source of unlimited power

Previously, the researchers reported creating two materials—carbonaceous sulfur hydride and yttrium superhydride—that are superconducting at 58 degrees Fahrenheit/39 million psi and 12 degrees Fahrenheit/26 million psi respectively, in papers in Nature and Physical Review Letters.

Given the importance of the new discovery, Dias and his team went to unusual lengths to document their research and head off criticism that developed in the wake of the previous Nature paper, which led to a retraction by the journal's editors. That previous paper has been resubmitted to Nature with new data that validates the earlier work, according to Dias. The new data was collected outside the lab, at the Argonne and Brookhaven National Laboratories in front of an audience of scientists who saw the superconducting transition live. A similar approach has been taken with the new paper.

Five graduate students in Dias's lab—Nathan Dasenbrock-Gammon, Elliot Snider, Raymond McBride, Hiranya Pasan, and Dylan Durkee—are listed as co-lead authors.

"Everyone in the group was involved in doing the experiments," Dias says. "It was truly a collective effort."

Creating 'reddmatter'

Hydrides created by combining rare earth metals with hydrogen, then adding nitrogen or carbon, have provided researchers a tantalizing "working recipe" for creating superconducting materials in recent years. In technical terms, rare earth metal hydrides form clathrate-like cage structures, where the rare earth metal ions act as carrier donors, providing sufficient electrons that would enhance the dissociation of the H2 molecules. Nitrogen and carbon help stabilize materials. Bottom line: less pressure is required for superconductivity to occur.

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In addition to yttrium, researchers have used other rare earth metals. However, the resulting compounds become superconductive at temperatures or pressures that are still not practical for applications.

So, this time, Dias looked elsewhere along the periodic table.

Lutetium looked like "a good candidate to try," Dias says. It has highly localized fully-filled 14 electrons in its f orbital configuration that suppress the phonon softening and provide enhancement to the electron-phonon coupling needed for superconductivity to take place at ambient temperatures. "The key question was, how are we going to stabilize this to lower the required pressure? And that's where nitrogen came into the picture."

Nitrogen, like carbon, has a rigid atomic structure that can be used to create a more stable, cage-like lattice within a material and it hardens the low-frequency optical phonons, according to Dias. This structure provides the stability for superconductivity to occur at lower pressure.

Dias's team created a gas mixture of 99% hydrogen and 1% nitrogen, placed it in a reaction chamber with a pure sample of lutetium, and let the components react for two to three days at 392 degrees Fahrenheit.

The resulting lutetium-nitrogen-hydrogen compound was initially a "lustrous bluish color," the paper states. When the compound was then compressed in a diamond anvil cell, a "startling visual transformation" occurred: from blue to pink at the onset of superconductivity, and then to a bright red non-superconducting metallic state.

"It was a very bright red," Dias says. "I was shocked to see colors of this intensity. We humorously suggested a code name for the material at this state—'reddmatter'—after a material that Spock created in the popular 2009 Star Trek movie." The code name stuck.

The 145,000 psi of pressure required to induce superconductivity is nearly two orders of magnitude lower than the previous low pressure created in Dias's lab.

Reaching the 'modern superconducting era'

With funding support from Dias's National Science Foundation CAREER award and a grant from the US Department of Energy, his lab has now answered the question of whether superconducting material can exist at both ambient temperatures and pressures low enough for practical applications.

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"A pathway to superconducting consumer electronics, energy transfer lines, transportation, and significant improvements of magnetic confinement for fusion are now a reality," Dias says. "We believe we are now at the modern superconducting era."

For example, Dias predicts that the nitrogen-doped lutetium hydride will greatly accelerate progress in developing tokamak machines to achieve fusion. Instead of using powerful, converging laser beams to implode a fuel pellet, tokamaks rely on strong magnetic fields emitted by a doughnut-shaped enclosure to trap, hold, and ignite super-heated plasmas. NDLH, which produces an "enormous magnetic field" at room temperatures, "will be a game-changer" for the emerging technology, Dias says.

Particularly exciting, according to Dias, is the possibility of training machine-learning algorithms with the accumulated data from superconducting experimentation in his lab to predict other possible superconducting materials—in effect, mixing and matching from thousands of possible combinations of rare earth metals, nitrogen, hydrogen, and carbon.

"In day-to-day life we have many different metals we use for different applications, so we will also need different kinds of superconducting materials," Dias says. "just like we use different metals for different applications, we need more ambient superconductors for different applications."

Coauthor Keith Lawlor has already begun developing algorithms and making calculations using supercomputing resources available through the University of Rochester's Center for Integrated Research Computing.

Futurity, 13 March 2023

https://futurity.org

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Technical Notes

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Association of polycyclic aromatic hydrocarbons exposure with child neurodevelopment and adult emotional disorders: A meta-analysis study

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The generation of environmentally persistent free radicals on photoaged microbeads from cosmetics enhances the toxicity via oxidative stress

Pesticide residues in nectar and pollen of melon crops: Risk to pollinators and effects of a specific pesticide mixture on Bombus terrestris (Hymenoptera: Apidae) micro-colonies

Spatial prediction and influencing factors identification of potential toxic element contamination in soil of different karst landform regions using integration model

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Associations between exposure to a mixture of phenols and sex steroid hormones among pre- and postmenopausal women: evidence from NHANES 2015-2016

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Non-negligible health risks caused by inhalation exposure to aldehydes and ketones during food waste treatments in megacity Shanghai