CHEMWATCH

Bulletin Board

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NOV. 18, 2022

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TECHNICAL NOTES

ASIA PACIFIC

Application to reassess the insecticide Actara

2022-11-04

We are seeking your views on a reassessment application to change controls for the insecticide Actara.

The Ministry for Primary Industries has applied to modify some controls so Actara can be used during an incursion of the brown marmorated stink bug.

The submission period closes on Tuesday 6 December 2022 at 11.59 pm.

The application

Actara contains the active ingredient thiamethoxam, a neonicotinoid insecticide, and is currently approved in New Zealand with controls.

The brown marmorated stink bug is one of the highest-risk biosecurity threats currently facing New Zealand, as it can cause significant damage to many important horticultural crops. It is also a significant social nuisance pest that can adversely impact personal wellbeing.

The application seeks to change two controls currently in place for Actara:

- An increase in the maximum number of applications of Actara (within any one target area) from four to 19 applications per year.
- An exemption from a control prohibiting application of an agrichemical where bees are foraging or on plants that are in flower or likely to flower.

The applicant requests these proposed changes are only made available to the Ministry for Primary Industries (Biosecurity New Zealand) for use in responding to a brown marmorated stink bug incursion.

Read More

EPA New Zealand, 04-11-22

https://www.epa.govt.nz/public-consultations/open-consultations/reassessment-of-actara/

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Air pollution in Delhi-NCR

2022-11-05

Context: Delhi pollution: From late October onwards, meteorological factors and 'stubble' burning to add to the already high pollution base in the Indo-Gangetic basin, particularly the pollution due to the Particulate Matter (PM), Haze and Smoke.

Particulate matter (PM) is made of solid particles and liquid droplets in the air. Any type of burning or dust-generating activity is a source of PM E.g., Emissions (from vehicles and industrial plant smokestacks)

Particulate matter—PM2.5 (diameter of 2.5 micrometres or less) and PM10—far exceeds national and World Health Organization limits and are considered the main culprit for high pollution of Delhi and its surrounding regions called NCR.

Reasons for Delhi NCR region facing extreme particulate pollution:

Geographical reasons:

- Location of Delhi: It lies to the northeast of the Thar Desert, to the northwest of the central plains and to the southwest of the Himalayas. As winds arrive from the coasts, bringing with them pollutants picked up along the way, they get 'trapped' right before the Himalayas.
- Cold temperature during winter: During summer hotter air rises higher above the surface and takes the pollutants along with it. However, during October-November, the air is not that hot. The pollutants are trapped and tend to get concentrated at lower levels of the atmosphere, resulting in the smoke and haze situation.
- Lack of wind esp. after the end of the monsoon: Average wind speed in winter in the Delhi NCR region is one-third of the summer months. This makes the pollutant concentration in the region.
- Dust Storm: -According to SAFAR (System of Air Quality and Weather Forecasting And Research), 40% of the particulate pollution in Delhi on those specific days could be sourced to a "multi-day dust storm" that originated in the Middle East.

Anthropogenic factors:

- Stubble burning: The root cause of stubble burning can be traced back to the 1960s-70s when India introduced several measures as part of its Green Revolution to feed its rising population.

- Governmental policy:In an attempt to address the growing water crisis, the Punjab and Haryana governments introduced laws, which delayed Kharif cropping and thus worsened the pollution due to stubble burning.
- Manufacturing activity, Power Generation, Construction, and Transport: The Central Pollution Control Board (CPCB) and the National Environmental Engineering Research Institute (NEERI) have declared vehicular emission as a major contributor to Delhi's increasing air pollution.
- Minimum Citizen participation: Unlike in other parts of the world, there is little citizens' movement for controlling pollution.
- Poor Regulations: Regulation is most often seen as imposing bans, not hand-holding and persuading industry – most of them small factories – into adopting environment-friendly measures
- India has not recognised in policy and law that air pollution is a killer.

Read More

Indian Express, 05-11-22

https://www.insightsonindia.com/2022/11/05/air-pollution-in-delhi-ncr/

Government Imposes Penalty On Violation Of Vehicles Ban Due To Decline in Air Quality

2022-11-05

The national capital is experiencing a sharp decline in air pollution. Due to the deteriorating air quality, Delhi has been placed in GRAP stage IV, which prohibits the use of some vehicles. A fine of Rs 20,000 will be assessed for violating the Delhi government's prohibition on the operation of certain cars due to the increase in pollution.

"Violating these curbs can attract a fine of Rs 20,000 under the Motor Vehicles Act," said an official.

According to the Central Pollution Control Board and SAFAR, a forecasting organization under the Ministry of Earth and Sciences, stubble burning accounted for 30% of the PM2.5 pollution in the city, and Delhi's air quality remained "severe" for the second day in a row.

The Commission for Air Quality Management (CAQM) suggested anti-pollution regulations that the Delhi government has chosen to put into action, including a ban on non-BS VI diesel-run light motor vehicles.

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Additionally, only diesel trucks transporting critical goods or offering important services would be permitted admission into Delhi.

The Transport Department issued a directive, allowing all CNG and electric trucks to enter Delhi.

Also Read: Assam: Yaba tablets worth 15 cr seized in Sonapur

Except for those transporting necessary goods or offering vital services, Delhi-registered diesel-powered medium, and heavy cargo vehicles would not be permitted to operate in Delhi.

Read More

Daily News Post, 05-11-22

https://www.dnpindia.in/nation/government-imposes-penalty-on-violation-of-vehicles-ban-due-to-decline-in-air-quality/120399/

AMERICA

FDA Proposes to Update Definition for "Healthy" Claim on Food Labels

2022-09-28

The U.S. Food and Drug Administration today issued a proposed rule to update the definition of the nutrient content claim "healthy." The "healthy" claim can act as a quick signal on food package labels to help empower consumers, including those with lower nutrition knowledge, with information to identify foods that will help them build healthy eating patterns. Today's action is just one part of the agency's ongoing commitment to reduce diet-related chronic diseases and advance health equity. In addition to the proposed rule, the FDA joined today's White House Conference on Hunger, Nutrition, and Health, highlighting the agency's support of the national strategy to improve nutrition and health and empower all consumers to make and have access to healthy choices.

Diet-related chronic diseases in the U.S. are the leading causes of death and disability. Healthy eating patterns, which include fruits, vegetables, lower-fat dairy and whole grains, are associated with improved health, such as reduced risk of cardiovascular disease, type 2 diabetes, certain types of cancers, and being overweight or obese. Providing informative and accessible food labeling empowers consumers and may help foster a healthier food supply for all if some manufacturers include more fruits,

vegetables, dairy and whole grains and limit saturated fat, sodium, and added sugars in their products, to qualify to use the updated claim.

The proposed changes to the definition of "healthy" are aligned with current nutrition science, the Dietary Guidelines for Americans, 2020-2025 and the updated Nutrition Facts label. The FDA's approach focuses on ensuring that nutrient-dense foods that help consumers to build a diet consistent with current dietary recommendations can qualify to bear the claim.

As an example, to include the "healthy" claim on the package, a cereal would need to contain a certain amount of whole grains and adhere to limits for saturated fat, sodium, and added sugars. Nuts and seeds, higher fat fish, such as salmon, certain oils, and water are examples of foods that cannot currently be labeled as "healthy" but are part of a healthy dietary pattern and recommended by the Dietary Guidelines and would qualify to bear the "healthy" claim under the proposed definition announced today.

Read More

US FDA, 28-09-22

https://www.fda.gov/food/cfsan-constituent-updates/fda-proposes-update-definition-healthy-claim-food-labels

Dry shampoos containing benzene remain on store shelves, study finds

2022-11-02

Dry shampoos — used as a quick fix between washes — are an increasing health concern, with more of the aerosol spray-on products found to be tainted with a cancer-causing chemical, according to findings released on Tuesday.

Benzene — the contaminant behind nationwide recalls of dry shampoos by Unilever and Procter & Gamble — is also showing up in products that remain on store shelves. That includes popular spray-on shampoos including Church & Dwight's Batiste and DeMert Brand's Not Your Mother's, the new study found.

New Haven, Connecticut-based Valisure tested 148 batches from 34 brands of spray-on dry shampoo and found benzene in 70%, the laboratory stated Tuesday in a news release.

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"Thirty percent had no detectable amount of benzene, so it can be made cleanly," David Light, CEO of the independent lab, told CBS MoneyWatch on Tuesday. "There's definitely a higher risk right now with propellant-based aerosol sprays," said Light, whose company last year first alerted the Food and Drug Administration to its findings of benzene in spray sunscreens, antiperspirants and hand sanitizers.

Read More

CBS News, 02-11-22

https://www.cbsnews.com/news/dry-shampoos-benzene-batiste-not-your-mothers-cancer-link-study-finds/

US EPA broadens its definition of PFAS

2022-11-04

The US Environmental Protection Agency is expanding its definition of per- and polyfluoroalkyl substances (PFAS)—at least for flagging contaminants for possible regulation in drinking water.

In the past, the agency used a limited definition of PFAS: "Chemicals with at least two adjacent carbon atoms, where one carbon is fully fluorinated and the other is at least partially fluorinated."An EPA Safe Drinking Water Act decision unveiled Nov. 2 broadens this definition to include fluorocarbons with highly branched carbon chains and some fluoroethers.

The decision adds PFAS as a group to the agency's list of substances that are candidates for regulation in drinking water. This means commerical PFAS, their byproducts, and their environmental transformation products will come under EPA scrutiny if they are detected in drinking water and meet the new definition. The agency previously listed only individual PFAS as candidates for such regulation.

This change is "an important first step towards identifying additional PFAS that may require regulation under the Safe Drinking Water Act," the agency says in a statement. Listing the chemicals as a group on the candidates list doesn't necessarily mean the agency will regulate PFAS as a category under the Safe Drinking Water Act, the decision says.

PFAS are synthetic chemicals widely used for water and stain resistance, fighting fires, and their ability to withstand harsh conditions. They are nicknamed "forever chemicals" because they resist breakdown. Some are known to be toxic, but most have not been tested extensively, if at all.

The agency's new three-part definition is more limited than one crafted by an international panel of scientists convened by the Organisation for Economic Co-operation and Development (OECD), which is a coalition of 38 of the world's highest-income countries, and the United Nations Environment Programme. Called the OECD definition, it includes any chemical with a perfluorinated methyl group or a perfluorinated methylene group, with few exceptions.

The EPA can add new contaminants to its list of candidates for drinking water regulation every 5 years. After listing, the agency requires large public drinking-water utilities to monitor for the contaminants and conducts or funds similar monitoring at some smaller water systems. After analyzing the resulting monitoring data, the agency must study at least five contaminants on the list and decide whether to regulate any of them. This process generally takes years.

Read More

c&en, 04-11-22

https://cen.acs.org/environment/persistent-pollutants/US-EPA-broadens-definition-PFAS/100/web/2022/11?utm_source=LatestNews&utm_medium=LatestNews&utm_campaign=CENRSS

Final Risk Evaluation for Methylene Chloride

2022-11-11

In November 2022, EPA released a final revised risk determination for methylene chloride as a whole chemical substance. This revision supersedes the previous condition of use-specific no unreasonable risk determinations in the 2020 methylene chloride risk evaluation (and withdraws the associated order). These chemical-specific changes are in accordance with the path forward for the first 10 risk evaluations under TSCA laid out by EPA in June 2021.

The final revised risk determination does not assume that all workers exposed to methylene chloride are always provided or appropriately wear personal protective equipment (PPE). The consideration of this information will be part of the risk management process.

EPA determined that 52 out of the 53 conditions of use evaluated would drive the determination that methylene chloride presents an unreasonable risk of injury to human health under its conditions of use.

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Read More

US EPA, 11-11-22

https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/final-risk-evaluation-methylene-chloride#documents

EUROPE

EU Commission Proposes Major Clean-up of Air and Water

2022-11-05

The EU Commission's proposed new rules to limit air and water pollution target a wide range of common chemicals and their producers, while making it easier for citizens to sue polluters for the health impacts of air pollution.

For some, the proposed rules go too far—and for others, not far enough.

The draft rules, released on October 26th, cut limits on air pollution by more than half, to align more closely with World Health Organization guidelines.

They would also enshrine in regulation the right for citizens to claim damages for the health effects of air pollution and to be represented collectively by NGOs. Air pollution and nanoparticles are known to contribute to a host of health problems including increasing the risk of stroke.

The rules would also update the Urban Wastewater Treatment Directive first put in place in 1991.

Most significantly, the draft rules add 25 substances to the list of pollutants, extends the 'polluter pays' principle to their removal of waste water, and requires tracking of industrial pollution "at the source."

The new pollutants include Per- and Polyfluorinated Substances (PFAS)—a large group of 'forever chemicals' common in cookware, clothing, furniture, and cosmetics—as well as many pesticides, the plasticiser Bisphenol A, and common drugs such as painkillers, anti-inflammatories, and antibiotics. According to the commission, 92% of toxic micro-pollutants in wastewater come from pharmaceuticals and cosmetic products.

The commission estimates that by 2040, 27% of the €3.8 billion annual cost of managing urban wastewater would be covered by industrial polluters, principally pharmaceutical and cosmetics companies.

The rules also mandate significant changes to the way wastewater is processed and monitored, requiring monitoring for microplastics and viruses such as COVID-19, recapturing phosphorus to be reused in fertilisers, and promoting the reuse of treated wastewater.

For wastewater companies, the measures are a step in the right direction, but aren't tough enough on chemical producers. Companies responsible for wastewater also warn that implementing the new rules will be expensive.

Read More

European Conservative, 05-11-22

https://europeanconservative.com/articles/news/eu-commission-proposes-major-clean-up-of-air-and-water/

Nutritional label: roundtable at the European Parliament

2022-10-28

The Italian Permanent Representation to the European Union organised on 26th October at the European Parliament the "Politics meets Nutrition Science" roundtable hosted by Vice President hon. Pina Picierno under the auspices of the Italian delegations of the European Parliament's political groups. The European Commission is expected to propose an harmonised EU front-of-pack labelling scheme in 2023 with a view of encouraging healthy diets and promoting a smoother functioning of the internal market.

In its impact assessment, the Commission examined four very different types of schemes: the French Nutri-Score, a "graded indicator" that assigns an overall grade to foods displayed through traffic-light colours; the English traffic lights, which express a separate evaluation for calories, sugars, salt and saturated fats, indicating their quantities; the Nordic countries KeyHole, a positive logo that is assigned to foods that, among those of the same typology, have a composition regarded as healthier; and finally the Italian NutrInform Battery, which provides information on the quantities of salt, fats, saturated fats and sugars in foods and indicates the incidence of a portion of the product on the daily requirement. Each of the

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four approaches has different consequences, which affect not only health but also fair competition, consumer freedom of choice, the future of local production and the different food cultures present within the European Union.

Ambassador Stefano Verrecchia said: "Italy remains committed to fostering an open and science-based debate on how to encourage healthy diets through adequate consumer information. We support the EU's laudable objective of reducing obesity and non-communicable diseases, but warn against disregarding national dietary traditions and artificially classifying some foods as healthy and others as unhealthy".

The roundtable was introduced by European Parliament's Vice President Ms. Pina Picierno and the Vice Minister of Agriculture of the Czech Republic which currently holds the EU Presidency, Mr. Jindřich Fialka. Members of the European Parliament held a fruitful debate on their expectations. The panellists discussed nutritional information on foods and the characteristics a nutritional label should have to empower consumers to adopt a healthy, varied and balanced diet.

Read More

EFA News, 28-10-22

https://www.efanews.eu/en/item/27290-nutritional-label-roundtable-at-the-european-parliament.html

INTERNATIONAL

G7: Russia would face 'severe consequences' for any use of chemical, biological or nuclear weapons

2022-11-04

The Group of Seven (G7) warned in a statement on Friday that Russia would face "severe consequences" if it uses any chemical, biological or nuclear weapons in its war with Ukraine.

The intergovernmental group of the world's largest democratic economies said that Russia's threatening rhetoric over using nuclear weapons is "unacceptable."

It additionally condemned a number of the country's other actions concerning the conflict and rejected the Kremlin's claims that Ukraine is

planning to launch a dirty bomb, an explosive that spreads radioactive material, against Russia.

The statement says that inspections from the International Atomic Energy Agency confirmed that Russia's allegations are baseless.

The group also outlined its positions on a range of other world conflicts, including Iran and North Korea's nuclear programs and reported Chinese human rights violations in the Xinjiang and Tibet regions.

Read More

The Hill, 04-11-22

https://thehill.com/policy/international/3720620-g7-russia-would-face-severe-consequences-for-any-use-of-chemical-biological-or-nuclear-weapons/

The Paris Agreement Is Working … For Now

2022-11-10

The world's much-maligned climate treaty has produced some stunning results.

This week, tens of thousands of diplomats, activists, and world leaders are gathering in Sharm el-Sheikh, Egypt, for the annual United Nations climate summit, known as COP27. They're meeting to discuss the ongoing implementation of the Paris Agreement, the global climate treaty that was finalized in 2015. The key issue is likely to be the pact's "loss and damage" provisions—diplomatic shorthand for whether rich countries, which have emitted the bulk of carbon pollution into the atmosphere, should reimburse poor countries facing climate-change-intensified disasters. It's one of the most controversial issues at the climate talks, and negotiators have kicked it down the road at each of the past handful of UN negotiations.

But the talks will also refocus attention on the Paris Agreement more broadly, and the international process that it jump-started seven years ago. The treaty, which is voluntary and nonbinding, has never been particularly revered: Many climate activists believe it doesn't go far enough—its text doesn't even mention fossil fuels, which cause climate change, by name—while climate-change-doubting politicians have demonized it. Yet its apparent mediocrity has hidden an important story that has played out slowly over the past few years. The Paris Agreement process seems to be working … at least for now.

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Let's refresh how the main process of the Paris Agreement is supposed to work. Every few years, each country makes a new pledge about how much it will cut emissions. A few years after making their pledges, negotiators gather at COP for a "global stocktaking" of how they did. There's no penalty for not hitting your target; the only punishment is getting "named and shamed" by other attendees, nonprofits, and the press. Then the cycle restarts, and countries make new, more ambitious pledges. This current conference is taking place in an "off" year for this cycle, when negotiators hash out other parts of the Paris Agreement or revisit other climate commitments.

Read More

The Atlantic, 10-11-22

https://www.theatlantic.com/science/archive/2022/11/paris-agreement-cop27-climate-change-international-collaboration/672052/

Window to claim registration numbers for NONS now closed

2022-11-02

Companies had until 17 July 2022 to claim the registration numbers assigned to their notifications of new substances (NONS). By the deadline, over 4 700 numbers remained unclaimed. These registration numbers can no longer be claimed or used by registrants.

Helsinki, 31 October 2022 - In 2008, ECHA assigned registration numbers to all substances notified under the Dangerous Substances Directive, for use by registrants under REACH. By 17 July 2022, almost half of the registration numbers remained unclaimed. The vast majority of registration numbers for NONS were claimed in 2008 and 2009, with claiming activity being very low in the past few years. A third of the unclaimed registration numbers stem from NONS made to the competent authority of the United Kingdom.

The unclaimed registration numbers cover 2 843 substances, mostly registered in low volumes and presumably already abandoned by their manufacturers or importers before 2008. 1 500 substances were covered only by registrations that were not claimed, suggesting these substances are not on the EU market at a volume requiring registration.

The information ECHA holds on the unclaimed NONS will remain available on ECHA's public database on chemicals. The database will, however, be updated to reflect that the registration numbers that remained unclaimed for these substances are not valid.

Read More

ECHA, 02-11-22

https://echa.europa.eu/en/-/window-to-claim-registration-numbers-for-nons-now-closed

Call for evidence: Investigation report on polyvinyl chloride and its additives

2022-11-02

We are looking for information on polyvinyl chloride (PVC) and its additives related to:

- uses;
- EU volumes per use sector and end-use;

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- end-of-life information per use; and
- experimental/measured release and exposure information.

This information will be used for the investigation report on PVC and its additives that the European Commission has asked us to prepare.

This call for evidence consultation is open until 6 January 2023

(23:59 Helsinki time).

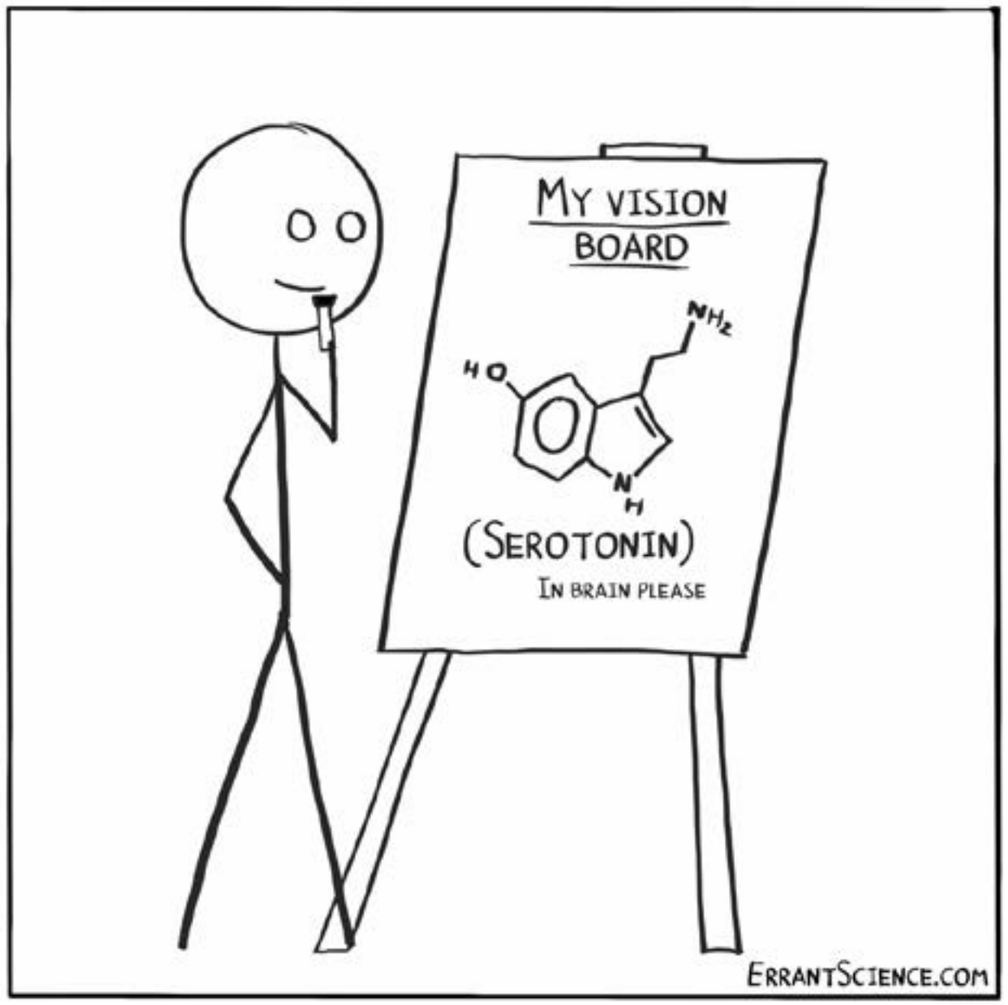
Read More

ECHA, 02-11-22

https://echa.europa.eu/view-article/-/journal_content/title/9109026-223

Vision Board

2022-11-18



twitter.com/ErrantScience/status/1588862368431443968

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Zinc Phosphide

2022-11-18

Zinc phosphide is an inorganic compound with the molecular formula Zn_3P_2 that combines phosphorus with zinc. [1] The IUPAC chemical name is trizinc diphosphide, and the CAS registry number is 1314-84-7. Zinc phosphide is a grey-black powder with an odour similar to garlic. It is practically insoluble in water and insoluble in alcohol. [2]

USES [3]

Zinc phosphide is used for rodent control on crops including grapes, sugarcane, artichoke, sugar beet, alfalfa, barley, berries, oats, sugar maple, wheat, corn, and hay. It is also used on grasses such as home lawns, rangeland, and golf courses. Zinc phosphide targets household rodent pests, such as mice and rats, in addition to field rodents including voles, ground squirrels, pocket gophers, prairie dogs, and jack rabbits.

ECOLOGICAL & ENVIRONMENTAL EFFECTS [2,3,4]

Zinc phosphide converts to phosphine gas in the presence of moisture and acid in the stomach. The toxicity of zinc phosphide is due to phosphine gas exposure. Thus, zinc phosphide must be ingested to become toxic. After phosphine is absorbed in the gastrointestinal tract, it inhibits cytochrome C oxidase, which is vital to mitochondrial respiration. It is suspected that there are other modes of action in its toxicity.

Zinc phosphide is highly toxic to wild birds and also to freshwater fish. Zinc phosphide is also toxic to non-target mammals when ingested directly. Secondary toxicity to mammalian predators (animals eating other animals that had been exposed to the compound) from zinc phosphide is rather low, primarily because the compound does not significantly accumulate in the muscles of target species. Some of the toxic effects to predators have been due to the ingestion of zinc phosphide that was in the digestive tract of the target organism.

Zinc phosphide may be applied as an active ingredient in either bait or a dust. Under average conditions, toxic activity persists for approximately 2 weeks. Soil acidity and moisture tend to accelerate the breakdown of the compound. Phosphine gas may be liberated as a result of this process.

Zinc phosphide is an inorganic compound with the molecular formula Zn3P2 that combines phos-phorus with zinc.

SOURCES & ROUTES OF EXPOSURE

Sources of Exposure [1]

Exposure can occur via contact to a pesticide containing zinc phosphide including contact with skin, breathe it in, or if you accidentally eat or drink a product containing it. This can happen if you get some on your hands and eat or smoke without washing your hands first. Young children and pets are most likely to be exposed to zinc phosphide by eating the bait pellets if they find them. Baits often have peanut butter, molasses, or other flavours that may attract dogs or children. You may also be exposed if you apply bait with your bare hands, or breathe in any dust or crumbled, powdery bait.

Routes of Exposure [5]

The main routes of exposure to zinc phosphide are:

- Inhalation
- Skin contact
- Eye contact
- Ingestion

HEALTH EFFECTS [2]

Acute Toxicity

Humans

- Zinc phosphide dust may release phosphine once it contacts the moist tissues of the respiratory tract if the dust is inhaled, resulting in pulmonary oedema and cardiotoxicity.
- If ingested, zinc phosphide releases phosphine in the gut and may cause headache, dizziness, fatigue, nausea and vomiting, cough, dyspnea, chest tightness, and thirst. Other signs include liver failure, jaundice, loss of ability to urinate, tetany, delirium, convulsions, coma, and death.
- Death in humans from fatal doses may be delayed for 30 hours after exposure, with the majority of tissue damage occurring in the liver, kidneys and heart.
- Victims of lethal phosphine exposure were found to have liver, myocardial, and alveolar cell necrosis, pulmonary oedema and microscopic pulmonary congestion, and anoxic damage in the brain.

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- Hyperglycaemia following exposure to phosphine has also been reported. Elevated levels of the enzyme creatine phosphokinase were found in two instances of severe poisoning by phosphine.28,29
- Phosphine have been shown to interfere with acetylcholinesterase in humans, but the impact of this inhibition on the toxicity is not clear.

Animals

- Animals that ingest zinc phosphide may begin showing clinical signs within 1 to 4 hours. Early signs of exposure include loss of appetite and depressed activity followed by vomiting and painful retching. These signs progress to anxiousness, ataxia or uncoordinated movements, weakness, laboured breathing, thrashing, muscle tremors and convulsions.
- Onset of signs may be delayed for up to 12 hours or more in animals who consumed the bait without any other food in their stomachs. Gastric acid release in animals that have recently eaten causes more rapid release of phosphine.
- The vomit of poisoned animals may contain blood. The vomit can also include phosphine, which can be dangerous to humans at levels below which its odour can be detected.

Chronic Toxicity

Humans

- Chronic, low-level inhalation or oral exposures to zinc phosphide in people have been associated with weakness, anaemia, toothache, necrosis of the jaw bones and associated swelling, weight loss, and spontaneous fractures.
- Blood samples taken from fumigant applicators and control subjects were examined for chromosomal abnormalities. Researchers collected samples during the application season, and 6 weeks to 3 months after application. Fumigant applicators who had been exposed to phosphine had more chromosome abnormalities than control subjects during the application season. Chromosomal rearrangements were more common in phosphine applicators than in controls 3 months after exposure.
- More recent investigations repeated the earlier work above, but found no such differences. One group of researchers hypothesised that improved personal protective equipment practices were responsible for the change. Other researchers reported that chromosomal breaks

were more prevalent in men who used fumigants relative to controls, but these applicators also used insecticides and herbicides.

Carcinogenicity

Humans

- The U.S. EPA determined that chronic exposure to zinc phosphide should be negligible and therefore waived carcinogenicity testing requirements for reregistration.
- No human data were found on carcinogenic effects of zinc phosphide or phosphine.

Endocrine Disruption

- No data were found on the ability of zinc phosphide or phosphine to disrupt the endocrine system.

Reproductive or Teratogenic Effects

- No human data were found on the teratogenic or reproductive effects of zinc phosphide or phosphine exposure.

SAFETY [5,6]

First Aid Measures

For Inhalation:

- Move victim to fresh air. Emergency personnel should avoid self-exposure to zinc phosphide.
- Evaluate vital signs including pulse and respiratory rate and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is laboured, administer 100% humidified oxygen or other respiratory support.
- Rush to a health care facility.
- Obtain authorisation and/or further instructions from the local hospital for performance of other invasive procedures.

For Skin and Eyes

- Remove victims from exposure. Emergency personnel should avoid self-exposure to zinc phosphide.
- Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing,

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provide artificial respiration. If breathing is laboured, administer 100% humidified oxygen or other respiratory support.
- Remove contaminated clothing as soon as possible.
- If eye exposure has occurred, eyes must be flushed with lukewarm water for at least 15 minutes.
- Wash exposed skin areas thoroughly with soap and water.
- Rush to a health care facility.
- Obtain authorisation and/or further instructions from the local hospital for performance of other invasive procedures.

For Ingestion

- Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is laboured, administer 100% humidified oxygen or respiratory support.
- Rush to a health care facility.
- Obtain authorisation and/or further instructions from the local hospital for performance of other invasive procedures.
- DO NOT INDUCE VOMITING or attempt to neutralise.

Fire & Explosion Information

- The product is not readily flammable. If there is a build-up of phosphine gas it may ignite when in contact with atmospheric oxygen if the concentration exceeds 1.79%. While kept dry the product is stable for long periods and the fire/explosion risk is minimal.
- Suitable extinguishing media: Use carbon dioxide or extinguishing powder. Do not use water. Move containers from the area if possible and if safe to do so. Fight fire in early stage only if safe to do so.
- Hazards from combustion: Oxides of phosphorous and oxides of zinc and hydrogen phosphide (phosphine) may be formed in a fire situation.

Exposure Controls & Personal Protection

Engineering Controls

- Use only in a well ventilated area.
- After handling zinc phosphide and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water.

Personal Protective Equipment

The following personal protective equipment is recommended when handling zinc phosphide:

- PVC gloves.
- Full face-piece respirator with combined dust and gas cartridge or supplied air respirator. For help in selecting a suitable mask consult AS/NZS 1715.
- After each day's use, wash gloves and respirator and if rubber, wash with detergent and warm water.

REGULATIONS [6,7]

United States

No occupational exposure limits have been established for zinc phosphide. However, as zinc phosphide can be converted to phosphine gas the following exposure limits apply to phosphine:

OSHA Permissible Exposure Limit (PEL):

- General Industry: 29 CFR 1910.1000 Table Z-1 -- 0.3 ppm, 0.4 mg/m3 TWA
- Construction Industry: 29 CFR 1926.55 Appendix A -- 0.3 ppm, 0.4 mg/m3 TWA
- Maritime: 29 CFR 1915.1000 Table Z-Shipyards -- 0.3 ppm, 0.4 mg/m3 TWA

American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV): 0.3 ppm, 0.42 mg/m3 TWA; 1 ppm, 1.4 mg/m3 STEL

National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL): 0.3 ppm, 0.4 mg/m3 TWA; 1 ppm, 1 mg/m3 STEL

Australia

There is no exposure standard allocated for zinc phosphide bait or zinc phosphide powder. However, the product may evolve phosphine gas, which presents a serious toxic risk. The time-weighted average (TWA) for phosphine gas is 0.42 mg/cubic metre (0.3ppm). The TWA is the average airborne concentration of the material which must not be exceeded when calculated over a normal 8-hour day and a 5-day working week.

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The short-term exposure limit (STEL) for phosphine gas is 1.4mg/ cubic metre (1.0ppm). The STEL is a value, which should not be exceeded for more than 15 minutes and which should not be equalled on more than four occasions per day. There should be a period of at least 60 minutes between successive exposures at the STEL.

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Lawsuits against the plastics industry for health and environmental harm could exceed $20 billion by 2030

2022-11-07

Thanks to new legal pathways, people around the world could sue plastics manufacturers for damages totalling more than $20 billion by 2030, with most lawsuits originating in the U.S., according to a new study.

The report, published by the Australian Minderoo Foundation, estimates that the plastics industry is costing society around $100 billion annually in environmental clean-ups, ecosystem degradation, shorter life expectancy and medical treatments. Minderoo is a philanthropic organization focused on the environment and climate, among other causes.

"We found that the negative impacts of plastic on human health are at least as consequential as the environmental risks about plastics that tend to dominate the story," Dominic Charles, director of finance and transparency at the Minderoo Foundation and one of the study's coauthors, told EHN. "Working to actually put a number on these social costs was a real eye opener."

To estimate these costs the researchers reviewed more than 5,000 academic papers to determine where there was scientific consensus on health harms associated with plastic ingredients. Then they estimated the global rates of disease and mortality associated with exposures to those ingredients to put a dollar amount on the public health costs. Finally, they worked with a group of attorneys who specialize in modeling risk for investors and insurers to estimate the legal liability plastics manufacturers are likely to face.

"The challenge is that plastics are completely ubiquitous, so it's very hard to pinpoint the source of a harmful exposure," Charles explained. "Eventually that leads you to the somewhat absurd conclusion that it doesn't matter how toxic your product is — as long as lots of companies are producing as much of it as possible, in as many different ways as possible, nobody has any liability. But that's something we're seeing change. There's an evolution being made in the legal doctrine to deal with that."

Lawsuits unfolding related to other ubiquitous chemicals like PFAS (per- and polyfluoroalkyl substances), glyphosate, and even opioids are forging new legal pathways, the report points out. In the case of PFAS, the chemicals are pervasive, with many companies selling products that contain them, but only a handful of companies manufacture them — and

A new study warns investors and insurers that plastic pollution is costing society $100 billion per year and litigation is coming.

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those are the companies being sued. The story is similar, Charles said, when it comes to the most harmful additives in plastic products.

"The plaintiffs in these cases are using innovative legal arguments, particularly related to public nuisance theories of harm, to successfully bring these cases forward," Charles said. "We think these kinds of new legal strategies will also open the door to plastic litigation."

How is plastic harming us?

While the research is still unfolding, the report concluded that there's "robust scientific consensus on human health harms resulting from some of the performance-enhancing chemical additives used in plastics."

These include certain phthalates, bisphenols (like BPA and its replacements) and flame retardants. All three classes of chemicals contain endocrine-disrupting compounds, which cause problems in the body's hormonal systems and are linked to significant health issues including infertility, early puberty, developmental issues like ADHD and autism, and metabolic disorders like type II diabetes and obesity. There's also evidence that they increase cancer risk.

The study estimates that manufacturers of these chemical additives are most likely to be exposed to litigation stemming from these health harms. Manufacturers of these types of chemicals include companies like BASF, Dow Chemical Company, Eastman Chemical Company and ExxonMobil Corporation.

The researchers also examined emerging research on the health harms associated with micro or nano plastics — microscopic plastic pieces that humans ingest through tap and bottled water, seafood, salts, milk, fruit and vegetables. Exposure has been linked to respiratory, immune, reproductive and digestive system problems and increased cancer risk.

"Micro or nano plastics have the same kind of persistence in the environment as PFAS chemicals," Charles said. "Those legal proceedings are going to be highly relevant to the future of plastics litigation."

Charles added that although these lawsuits could total billions of dollars, they won't keep pace with the social costs, especially in the near term. These hazards enter the stream of commerce and it's many years later that scientists start piecing together how harmful they are, he said. Then, it takes years to reach a scientific consensus, and it still takes years before lawyers take action after that.

"That's why the threat of liability isn't working as a sufficiently preventative measure right now," he said. "We also need to change the way we're regulating these chemicals."

The American Chemistry Council, a trade and lobbying group for chemical manufacturers, issued a statement saying the report is "detached from reality" and emphasizing that plastics are important to modern medicine and innovation. A spokesperson for the group declined to answer questions about what specific aspects of the report the Council disagrees with, and whether the group has ever conducted its own risk assessments or addressed potential litigation related to health and environmental damages from plastics.

What does this mean for petrochemical development?

In the first 13 years of the 21st century, plastics manufacturing surpassed total production in the last century, and production is expected to double again in 20 years and almost quadruple triple by 2050. Lawsuits have the potential to slow that growth.

"This report is basically communicating that if you invest in plastics, you're taking a calculated risk and there are threats looming," Sean O'Leary, a senior researcher focused on energy and petrochemicals at the Ohio River Valley Institute, a progressive think tank, told EHN.

O'Leary, who was not involved in the Minderoo study, said petrochemical development in Appalachia's Ohio River Valley, which spans parts of western Pennsylvania, Ohio, West Virginia, Virginia, Kentucky, Indiana, Illinois and Tennessee, has already been hampered by unfavorable market conditions for plastics.

Shell is about to open a massive new plastics plant in the Ohio River Valley, about 35 miles northwest of Pittsburgh, which will turn fracked ethane gas into up to 1.6 million metric tons of plastic pellets annually, most of which are expected to produce single-use packaging and plastic bags. It's one of five such facilities that have been proposed in the Ohio River Valley, but the only one that's gotten off the ground. None of the other projects are expected to move forward.

Other plans "died not because we convinced a lot of investors to become more climate conscious or environmentally caring," O'Leary said, "but because we demonstrated that these investments were not wise ones."

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"Shell still has additional investment decisions to make concerning their plant," he added, "and now they'll have to take into account at least the possibility of legal action and the risk posed by that."

Residents near Shell's plant have expressed concern about how the millions of tons of air pollution the plant will generate annually will impact their health. The Minderoo report only briefly acknowledges liability related to pollution from plastics manufacturing plants, but Charles said these communities are particularly at risk from the effects of the industry.

"Exposures around production facilities are relatively small compared to the ubiquitous exposures and potential liabilities arising from plastics as a whole," he said. "That said, they are probably easier to build a case on, and those cases may well be some of the first to be brought in terms of plastic litigation."

Environmental Health News, 7 November 2022

https://ehn.org

New native bee species with distinctive 'snout' discovered in Perth's Kings Park

2022-11-05

The bee's 'snout' allows it to collect pollen from a specific native pea plant.

When ecologist Kit Prendergast was surveying native bee populations in Perth's Kings Park botanic gardens, the last thing she expected to discover was a new bee species — with a very distinctive snout.

"I came across this really unusual species, and it had this big protrusion on its face," she said.

"Bees don't have noses, they smell with their antennae — but it looked like a snout.

"I thought I would be able to identify [it] quite easily because it's a very obvious feature.

"So I went and did lots of photographs, lots of looking at what the diagnostic features were. I talked to the taxonomists in the WA Museum — they said it was probably a new species."

After searching the WA Museum's entomology collection, Ms Prendergast discovered a few specimens of the species had been collected in 1979.

But it remained undescribed scientifically.

"It's been a dream of mine to find and describe a new species of native bee," she said.

"And whoever describes a new species, the taxonomist gets to have naming rights.

"The only rule is that you can't name it after yourself because that's really egotistic.

"You can name it after something descriptive, a location, or even a famous person or someone who is significant in your life – which is exactly what I did."

Dr Prendergast named the species Leioproctus Zephyr, after her beloved pet dog Zephyr.

"[My dog] has been with me through my hardest times, she has loved me unconditionally," she said.

Discovery highlights native bushland's importance

She said the bee's "snout" was most likely used to help the species forage in a very limited range of host plants called Jacksonia sericea, a type of native pea flower.

"They've got this flower structure where the petals have sort of a keel and inside the keel is the nectar and pollen, and it needs to be pushed open to access those rewards," she said.

"It seems like this snout in the middle of its face is used to push up in the keel so it can easily access the nectar."

Dr Prendergast said the discovery highlighted the importance of maintaining pockets of urban bushland and planting native flowers.

"Our native bees are extremely specialised — you can have a garden full of flowers, but if they're all exotic flowers, it's essentially a desert to the native bees," she said.

"These [native plants] need to be propagated and made available to the public.

"Bushland remnants have to be conserved because without them, we wouldn't have this native bee species.

"It is already super rare, and only occurs in a handful of locations, because it is specifically tied to this host plant."

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New discoveries yet to be made

Dr Prendergast said there were 1,661 native bee species already described in Australia, but there was an estimated 2,000 species yet to be identified.

"One of the saddest things is that there's almost no investment into monitoring our native bees, so we don't have good population data," she said.

"Some native bees have been only collected from a few locations decades ago, and there's been no collection since.

"They might have gone extinct in those locations — it is something that we need to be concerned about."

ABC News, 5 November 2022

https://abc.net.au

The Brain Isn't Symmetrical – Researchers Reveal New Insight About the Brain

2022-11-06

The brain's hemispheres are not equal.

The scientists found that asymmetry is influenced by a person's experiences.

At first glance, the human body seems to be symmetrical: two arms, two legs, two eyes, two ears, and even the nose and mouth appear to be mirrored on an imaginary axis that divides most people's faces. Finally, the brain is split into two nearly equal-sized halves, and the furrows and bulges follow a similar pattern. The initial impression, however, is misleading since there are small, functionally relevant differences between the left and right sides of the different brain regions.

The two hemispheres have distinct functional specializations. For instance, most individuals process language mostly in their left hemisphere whereas spatial attention is primarily processed in their right hemisphere. Work can thus be distributed more effectively to both sides, and the overall range of tasks is expanded.

However, this so-called lateralization, or the tendency for brain regions to process certain functions more in the left or right hemisphere, differs between people. And not only in the minority whose brains are mirror-inverted in comparison to the majority. Even people with classically arranged brains have varying degrees of asymmetry. Previous research

has indicated that this, in turn, may have an effect on the functions themselves.

For instance, dyslexia is characterized by a lack of left asymmetry in certain language areas. Inadequate brain lateralization may also contribute to conditions such as schizophrenia, autism spectrum disorders, and children's hyperactivity.

Until now, however, it hasn't been clear how much brain asymmetry variance, across individuals, is heritable and how much is due to different demands. Furthermore, are similar features of brain asymmetry also present in monkeys?

Scientists at the Max Planck Institute for Human Cognitive and Brain Sciences (MPI CBS) and Forschungszentrum Juelich (FZJ) have now investigated the asymmetry of functional gradients, describing axes of smooth variations of brain function across the cortex. They found that there are subtle variations in the functional organization of brain regions on the left and right sides of the brain. On the left side, regions involved in language processing are most distant from those implicated in vision and sensation.

Whereas on the right side the so-called frontoparietal network, responsible for attention and working memory, for example, is most distant from those sensory regions. The researchers also found that individual differences in these functional arrangements were heritable, meaning that they are partly influenced by genetic factors. At the same time, a large portion of this asymmetry in human brains could not be accounted for by genetic factors. This means some asymmetry is influenced, at least in part, by the person's experience.

In addition, the team found that human brains are more asymmetric than those of monkeys. "It is likely that the observed functional asymmetry reflects the interplay of both genetic and non-genetic effects derived from personal experiences" explains Bin Wan, a Ph.D. student at MPI CBS and lead author of the study recently published in the journal eLife. Indeed, in older people, they observed reduced right-ward asymmetry, suggesting subtle variation across the lifespan.

"We want to understand why subtle differences between the left and right hemispheres are relevant for language and attention and implicated in various developmental disorders", explains Sofie Valk, head of the study and the Cognitive Neurogenetics research group at MPI CBS. "If we understand the heritability of the asymmetry, this would be an initial step

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towards understanding the role of genetic and environmental factors in shaping this trait. We may eventually be able to figure out where something goes wrong when the difference between left and right is disturbed."

The researchers investigated these connections using two databases, one containing human brain scans, including twins, and the other containing brain scans of 19 macaque monkeys. By comparing monozygotic twins, dizygotic twins, and unrelated individuals, they were able to determine how siblings differ from each other, and therefore, what is not genetically determined but due to environmental influences.

In turn, the comparison with macaques made it clear where differences between humans and monkeys lie and which have arisen through evolution. The scientists calculated these differences with the help of a so-called low-dimensional, functional brain connectivity organization. This reveals the degree to which separate brain regions can work together. The researchers computed this organizational feature in each hemisphere and then calculated the asymmetry index by subtracting right from left.

Sci Tech Daily, 6 November 2022

https://scitechdaily.com

First human patients receive transfusions of lab-grown blood cells

2022-11-06

For the first time ever, human patients have received transfusions of blood cells that were grown from stem cells in a lab. A clinical trial investigating the safety of the procedure is currently underway, which could revolutionize blood transfusions.

Blood donations can be life-saving, especially for people with disorders like sickle cell anemia. But demand far outstrips supply, and matching blood types is an extra hassle that often results in patients missing out even as donated blood goes to waste.

An attractive alternative would be large-scale production of red blood cells in labs, which can be tuned to have whichever blood type is needed. Scientists have been working towards this goal for decades, and now a major milestone has been achieved with the first ever transfusion of lab-grown blood into human patients.

Red blood cells normally have a lifespan of around 120 days, but conventionally donated blood contains a random sample of cells of different ages.

The technique still starts with blood from a donor, but in this case it's not the red blood cells scientists are after – it's the blood stem cells. These are isolated and placed in a nutrient solution for 18 to 21 days, encouraging them to multiply and develop into more mature blood cells. These are then further purified and stored, ready for transfusion.

The new clinical trial, named RESTORE, is designed to test the safety of transfusions of these manufactured blood cells, as well as how long they last in the body. Red blood cells normally have a lifespan of around 120 days, but conventionally donated blood contains a random sample of cells of different ages. Lab-grown blood, on the other hand, is all made "fresh," so it should all reliably last up to 120 days.

The RESTORE trial will involve at least 10 participants receiving "mini" transfusions of blood, containing just 5 to 10 ml (one to two teaspoons) of red blood cells. They will each be given two of these mini transfusions, four months apart – one will be lab-grown blood cells, and the other standard donated blood. They will then be monitored for any side effects, and specifically to check whether the lab-grown blood lasts longer, as expected.

So far, two participants have received transfusions of lab-grown blood cells as part of the trial, with the scientists reporting that they have shown no untoward side effects.

With further development, lab-grown blood cells could offer a few advantages over conventional blood donation. For people with conditions that require regular blood transfusions, the longer lifespan of the cells should help give them longer gaps between transfusions. And it could reduce the need to match blood types between donors and recipients, potentially alleviating shortages in the long run.

While this is a major milestone towards that goal, there's still much more work to do before blood transfusions are regularly lab-grown. In the meantime, blood donors are still very much in demand.

New Atlas, 6 November 2022

https://newatlas.com

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Fertilizers limit pollination by changing how bumblebees sense flowers

2022-11-09

Pollinators are less likely to land on flowers sprayed with fertilizers or pesticides as they can detect electric field changes around the flower, researchers at the University of Bristol have found.

The study, published in PNAS Nexus today, shows that chemical sprays alter the electric field around flowers for up to 25 minutes after exposure. This impact lasts substantially longer than natural fluctuations, such as those caused by wind, and causes a reduction in bee feeding effort in nature.

Dr. Ellard Hunting of Bristol's School of Biological Sciences and his team noted that fertilizers did not affect vision and smell, and set out to mimic the electrical changes caused by fertilizers and pesticides in the field by electrically manipulating flowers. This showed that bumblebees were able to detect and discriminate against the small and dynamic electric field alterations that are caused by the chemicals.

Dr. Ellard Hunting said, "We know that chemicals are toxic, but we know little about how they affect the immediate interaction between plants and pollinators.

"Flowers have a range of cues that attract bees to promote feeding and pollination. For instance, bees use cues like flower odor and color, but they also use electric fields to identify plants.

"A big issue is thus—agrochemical application can distort floral cues and modify behavior in pollinators like bees."

Furthermore, various other airborne particles such as nanoparticles, exhaust gases, nano-plastics, and viral particles may have similar impacts, affecting a wide array of organisms that use the electric fields that are virtually everywhere in the environment.

Co-author, Bristol's Sam England, explained, "What makes this study important is that it's the first known example of anthropogenic 'noise' interfering with a terrestrial animal's electrical sense.

'"It's much like motorboat noise that hinders the ability of fish to detect their predators, or artificial light at night that confuses moths; the fertilizers are a source of noise to bees trying to detect floral electrical cues.

"We know that chemicals are toxic, but we know little about how they affect the immediate interaction between plants and pollinators."

"This widens our understanding of the multifaceted ways in which human activity is negatively impacting the natural world, which can seem quite depressing, but it will hopefully allow is to introduce or invent solutions to prevent the adverse effects that these chemicals may be having on bees."

Dr. Ellard Hunting added, "The fact that fertilizers affect pollinator behavior by interfering with the way an organism perceives its physical environment offers a new perspective on how human-made chemicals disturb the natural environment."

Phys Org, 9 November 2022

https://phys.org

New antibiotic passes through the first phase of clinical trials with ease

2022-11-09

A new antibiotic, developed in Australia, which might help address the burgeoning problem of antibiotic resistance, has successfully completed the first stage of clinical trials.

The drug, called QPX9003, is a promising candidate for tackling Gram-negative bacteria which cause serious infections like pneumonia, urinary tract infections, peritonitis and meningitis.

Gram-negative "superbugs" are becoming increasingly hard to treat, as they develop resistance to most common antibiotics.

QPX9003 was administered in both single 400mg doses, and multiple doses totalling 600mg per day over two weeks, with no adverse effects and no-one dropping out of the trial.

"The drug has an excellent safety and tolerability profile, and we anticipate that the drug would also be effective in patients in terms of targeting these drug-resistant bacteria," says Dr Kade Roberts, a research fellow at Monash's Biomedicine Discovery Institute, and the Chemistry Team Leader of the group that's developed the antibiotic.

Getting the antibiotic to this point has taken a decade of work, and funding from multiple sources – including both the Australian and US governments' health research funds.

It started when a research team, headed up by Monash's Professor Jian Li, began investigating a class of antibiotics called polymyxins.

The drug is getting closer to being part of our antibiotic resistance arsenal.

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"They're a very old class of antibiotics that were discovered in the 1940s. They're now used as a last resort therapy when nothing else works," says Roberts.

This is because polymyxins can be toxic to people at clinical doses, and they don't target infections well in the lungs, which can be a major site for antibiotic resistant infections.

"We re-engineered the polymyxins to come up with a new drug that's more effective at targeting infections in the lungs, and also prevents the toxicity issues associated with this particular drug class," says Roberts.

The new drug is a type of compound called a lipopeptide.

US biopharmaceutical company Qpex Biopharma Inc has licenced the drug from Monash, and worked with researchers to develop the drug.

If QPX9003 makes it through Phase II and III clinical trials and onto the market, it will be the first new lipopeptide antibiotic that targets Gram-negative bacteria in over 60 years.

"These particular Gram-negative bacteria which our drug targets have been highlighted by the World Health Organization as being the top priority for the development of new antibiotic drugs," says Roberts.

The drug is still several years away from pharmacy shelves – it still needs to get through bigger clinical trials to demonstrate its efficacy. Then, there's economics to consider.

"The financial incentive for pharmaceutical companies to invest money into developing new antibiotic drugs is just not the same as for it is other medical indications such as oncology and the development new cancer drugs," says Roberts.

"Companies can make a lot more money developing new cancer drugs than they can developing new antibiotics. So it's been left up to smaller biotech companies and academic research groups to fill that critical void."

The results from the Phase I placebo-controlled randomised trial for QPX9003 have been presented at the Infectious Diseases Society of America conference in Washington DC, US.

Cosmos, 9 November 2022

https://cosmosmagazine.com

Antibody therapy proves 88% effective at preventing malaria infections

2022-11-07

In the first big real-world test for monoclonal antibodies against malaria a new study has reported extraordinarily promising results, with a novel therapy found to be 88.2% effective at preventing infections across a six-month period. The results add to a growing body of research focusing on antibody therapy as a tool to fight malaria.

As the world's first malaria vaccine began its roll-out last year in Africa, several major philanthropic organizations began to question whether the vaccine's efficacy was good enough for a wide roll out. With trials finding the vaccine may only prevent 30% of infections in children, non-profit organizations such as the Bill and Melinda Gates Foundation ultimately diverted funding from vaccine deployment into other malaria prevention studies.

While work on malaria vaccines continues, some research attention is shifting to monoclonal antibody therapies. These therapies focus on directly delivering substantial volumes of potent protective antibodies to a person, instead of using a vaccine to prompt the immune system to produce its own antibodies.

Monoclonal antibodies are effective tools because the antibodies administered can be explicitly optimized to target certain antigens. However, they are not long-lasting therapies. The antibodies degrade over time, and treatments are often only effective for several months.

This new research focuses on an antibody dubbed CIS43LS. The antibody was first isolated from a patient who had received an experimental malaria vaccine and it was then modified so it wouldn't degrade too rapidly.

In a Phase 2 trial, the first big real-world test for malaria-preventing monoclonal antibodies, 330 healthy adults were evenly split into three groups: low- and high-dose antibody groups and a placebo. The trial took place over the six-month rainy season in rural communities in Mali, Africa.

The trial found the highest dose of the antibody was 88.2% effective at preventing malaria infections over the six-month study compared to placebo. The lowest dose was 75% effective at preventing infection.

"These first field results demonstrating that a monoclonal antibody safely provides high-level protection against intense malaria transmission in healthy adults pave the way for further studies to determine if such

A monoclonal antibody treatment for malaria is currently administered through intravenous infusion but next-generation antibodies are in development that can be given via a single injection.

an intervention can prevent malaria infection in infants, children, and pregnant women," explained Robert Seder, one of the lead researchers working on the antibody project. "We hope monoclonal antibodies will transform malaria prevention in endemic regions."

The trial is a strong proof-of-concept showing how effective monoclonal antibodies could be at preventing malaria infections. But it's unlikely CIS43LS will be the treatment that ultimately reaches clinical use.

In its current form the treatment needs to be administered via intravenous infusion. However, the researchers have already developed a second, more potent, form of the antibody dubbed L9LS.

This next-generation L9LS antibody can be administered as a subcutaneous injection, making it a much more scalable treatment, especially in more remote communities. Phase 1 trials have already been completed, with promising results paving the way for larger Phase 2 trials currently underway.

Because monoclonal antibodies are only effective for a short period of time they will never serve as a replacement for vaccines. The researchers do speculate a number of valuable uses for monoclonal antibodies, especially in the short-term while more efficacious vaccines are being developed.

"A single dose of a monoclonal antibody that prevents infection for up to six months could be administered before each malaria season for at-risk children and in early pregnancy, complementing chemoprevention and other control measures," the researchers noted in the study. "Monoclonal antibodies could potentially be used in combination with mass drug administration and other countermeasures for malaria elimination. Finally, for travelers to areas in which malaria is endemic, monoclonal antibodies could provide an alternative to chemoprophylaxis that can be associated with side effects and inadequate adherence."

The new study was published in The New England Journal of Medicine.

New Atlas, 7 November 2022

https://newatlas.com

Electrical stimulation helps paralysed people walk again — and now we know why

2022-11-09

Neuroscientists have identified the nerve cells responsible for helping paralysed people to walk again, opening up the possibility of targeted therapies that could benefit a wider range of people with spinal-cord injuries.

Severe spinal-cord injuries can disrupt the connection between the brain and the networks of nerve cells in the lower spine that control walking. In 2018, neuroscientist Grégoire Courtine at the Swiss Federal Institute of Technology in Lausanne and his colleagues showed that delivering electrical pulses to those lower-spine nerves — a technique known as epidural electrical stimulation (EES) — could, when combined with intensive training, get people with this kind of spinal-cord injury walking again. All three participants in a trial went from having severe or complete motor paralysis and minimal sensation in their legs to being able to take steps on their own, or with a walker or crutches. Two other teams showed similar results that year.

Courtine's team has now extended the work, showing that the system works in people who have lost all sensation in their legs. The group reports in Nature today that nine participants in the same trial — three of whom had complete paralysis and no sensation in their legs — regained the ability to walk after training paired with EES delivered by devices implanted in their spines. Five months into the trial, all participants could bear their own weight and take steps, using a walker for stability.

Four no longer need the EES to be switched on to walk. This sustained recovery suggests that the stimulation triggers remodelling of the spinal neurons to bring the locomotion network back on line.

"The amount of hope that it gives to people with spinal-cord injury is incredible," says Marc Ruitenberg, a neurologist at the University of Queensland in Brisbane, Australia, who studies spinal-cord injury.

Dampened activity

Courtine's team also discovered the neurons responsible for the rehabilitation enhancement. Counter-intuitively, when EES was switched on in people, nerve-cell activity at the site of stimulation decreased. The team used this clue to investigate the process more thoroughly. First, the researchers emulated each aspect of the treatment in mice — from injury and electrical stimulation to training with a purpose-built robotic support for stability. The results mimicked those in people.

Detailed gene-activity map could pave way for more precise treatments for many more people with spinal-cord injuries.

Next, the researchers measured gene activity in thousands of individual neurons in samples of mouse spinal tissue. This produced an exquisitely detailed map of nerve cell types in the lower spinal cord. They then used a machine-learning algorithm to search for mouse neurons that showed changes in gene activity at set stages of EES-assisted rehabilitation that paralleled the changes observed in the human participants' walking ability.

The algorithm identified a subpopulation of excitatory interneurons — nerve cells that connect motor and sensory neurons — that seemed to fit. When Courtine's team silenced those cells in injured mice, they found that EES no longer enabled the injured animals to walk.

The overall decrease in neural activity at the site during rehabilitation reflects a learning process, says Courtine. "When you think about it, it should not be a surprise," he says, "because in the brain, when you learn a task, that's exactly what you see — there are less and less neurons activated" as you get better at it.

Next steps

Technology doesn't exist to gather this kind of direct evidence in people. But Eiman Azim, a neuroscientist at the Salk Institute for Biological Studies in La Jolla, California, says the same neurons are probably responsible for the effect, because spinal architecture is very similar across vertebrates, including humans and mice.

Eventually, says Azim, detailed understanding of the spinal circuitry could allow neuroscientists to manipulate the activity of specific neurons directly with other treatments, such as gene therapy. Stem-cell therapies could one day replace crucial populations of neurons damaged in spinal-cord injuries, says Ruitenberg.

Courtine and his colleagues have also used EES to restore arm movement and hand grip in monkeys. And a group at the University of Washington in Seattle has done the same for six people with spinal-cord injuries, using non-invasive electrode-bearing skin patches placed on the neck.

As spectacular as it is to see people with spinal-cord injuries walk again, Ruitenberg says that walking is often not a priority for people. Loss of bladder control, bowel control and sexual function can have a greater impact on quality of life. "It would be really interesting to see whether

those sorts of functions also can be improved with this technology," he says.

Courtine says that identifying the nerves responsible for these functions is on his list of next steps now that he has a detailed molecular map to work with. He has also launched a start-up company — ONWARD, based in the Netherlands — to commercialize the technology. The company will start recruiting 70–80 participants in the United States for a new trial in 2024.

Nature, 9 November 2022

https://nature.com

Rare, deadly genetic disease successfully treated in utero for first time

2022-11-10

Using a protocol developed at UC San Francisco, physicians have successfully treated a fetus with a devastating genetic disorder for the first time, and the child is now thriving as a toddler, a case study in the New England Journal of Medicine reports.

"This treatment expands the repertoire of fetal therapies in a new direction," said co-senior and corresponding author Tippi MacKenzie, MD, a pediatric surgeon at UCSF Benioff Children's Hospitals, co-director of UCSF's Center for Maternal-Fetal Precision Medicine and director of the Eli and Edythe Broad Center of Regeneration Medicine and Stem Cell Research. "As new treatments become available for children with genetic conditions, we are developing protocols to apply them before birth."

The child's disorder, infantile-onset Pompe disease, is one of several lysosomal storage diseases that begin to cause severe damage to major organs, such as the heart, before birth. By initiating enzyme replacement therapy during fetal development, physicians aimed for better outcomes than are typical with post-birth treatment—outcomes that can include death in early childhood, very low muscle tone or ventilator dependency.

After six prenatal enzyme replacement treatments at The Ottawa Hospital, the child, Ayla, was born at term. She is receiving postnatal enzyme therapy at CHEO (a pediatric hospital and research center in Ottawa, Canada), and doing well at 16 months of age. She has normal cardiac and motor function and is meeting developmental milestones.

"When we were having Ayla, we didn't know if she'd be able to walk," said Zahid Bashir, Ayla's dad. "We didn't know if she'd be able to talk. We didn't know if she'd be able to eat. We didn't know if she'd be able to laugh. So, as she hits each of these milestones, we continue to be amazed at her progress. So, yeah, it's quite something, that I think sometimes we may take for granted, but most of the time we're quite aware that she's a miracle."

The child's disorder, infantile-onset Pompe disease, is one of several lysosomal storage diseases that begin to cause severe damage to major organs.

A triumph of collaboration

The successful treatment is a feat of collaboration between UCSF, where an ongoing clinical trial on the treatment is based; CHEO and The Ottawa Hospital, where the patient was diagnosed and treated; and Duke University, home to the world's top experts on Pompe disease.

"We really needed this multidisciplinary group of people to lend their deep expertise to all aspects of care," said MacKenzie, who holds a Benioff UCSF Professorship in Children's Health and a John G. Bowes Distinguished Professorship in Stem Cell and Tissue Biology. "Enzyme replacement therapy is a new frontier in the field of fetal therapy; it has been exciting to see it grow from a research project in my laboratory to impact the outcome for this family ultimately. UCSF is considered the birthplace of fetal surgery, and it is a special privilege for us to continue to expand the technologies and treatments available to help families facing a difficult diagnosis during pregnancy."

Under usual circumstances, the patient's family would have traveled to the UCSF Benioff Children's Hospital Fetal Treatment Center to participate in the clinical trial. When COVID-19 restrictions made international travel unfeasible, experts from the two Canadian and two American hospitals met the family as a team by video to discuss alternatives. UCSF shared the treatment protocol with the team in Ottawa, where the family lives. Throughout the process, the entire team met weekly by video to discuss the health of the mother and fetus and to monitor the response to treatment.

"We have been treating our fetal patients using intrauterine therapy for more than 30 years," said Karen Fung-Kee-Fung, MD, the family's maternal-fetal medicine specialist at the Ottawa Hospital and professor of obstetrics and gynecology at the University of Ottawa. "The emergence of a new medical treatment to lift the burden of Pompe disease for this family, and potentially help other families affected by devastating genetic diseases, is both exciting and incredibly satisfying. We feel very privileged and honored to be a part of this international collaboration to help make this first-in-the-world treatment a reality."

Pranesh Chakraborty, MD, a pediatrician and metabolic geneticist at CHEO and co-lead of the case study, has provided care to the family for years. "This treatment is very promising, and I am so happy for Ayla and her family," said Chakraborty, who is also a researcher at the CHEO Research Institute and an associate professor at the University of Ottawa. "Having had the privilege and heartbreak of walking alongside families who have lost children to these devastating diseases, this work is very important to me."

A big step forward for fetal therapy

Babies born with infantile-onset Pompe disease typically have enlarged hearts and die within two years if untreated. The disease is very rare, seen in less than 1/100,000 live births, and is caused by mutations in a gene that makes acid alpha-glucosidase, an enzyme that breaks down glycogen. Without it or with limited amounts, glycogen accumulates dangerously in the body.

"From our long-standing work at Duke treating patients with Pompe disease, we know first-hand the critical importance of earlier initiation of treatment," said Jennifer Cohen, MD, co-lead author of the study and assistant professor in the Division of Medical Genetics in the Department of Pediatrics at Duke University School of Medicine. "Our ability to offer a new treatment opportunity to this family and potentially change the course of this difficult disease has made this collaboration and project groundbreaking," added Cohen.

Duke has played a pivotal role in many advances in the field of Pompe disease, including developing alglucosidase alfa as the first Food and Drug Administration-approved enzyme replacement therapy (ERT) for Pompe disease, identifying the role of high and sustained antibody titers to the ERT, using biomarkers to follow treatment response, and establishing immune tolerance induction protocols for the most severe patients, noted Priya Kishnani, MD, co-senior author, division chief of Medical Genetics at Duke University School of Medicine. "All of these advances were crucial to this particular patient's treatment and response," said Kishnani. "The intrauterine therapy represents a new frontier for patients with Pompe disease."

Pompe is one of eight lysosomal storage diseases that UCSF has received FDA approval to treat with enzyme replacement therapy in utero for a Phase 1 clinical trial of 10 patients. The other diseases are Mucopolysaccharidosis types 1, 2, 4a, 6 and 7, Gaucher disease types 2 and 3, and Wolman disease.

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The researchers hope the success of this first application and publication of the case study will increase awareness of the UCSF clinical trial among parents at known risk of passing on these diseases and the physicians who treat them.

"Seeing how well Ayla is doing, it is important to pursue clinical trials to establish whether this kind of fetal therapy will be a good option for other families when treatment in the newborn period just isn't early enough," said Chakraborty, who directs the provincial program Newborn Screening Ontario based at CHEO. "We are working hard to try to improve access to this trial for other Canadian families."

Two additional patients with different lysosomal diseases have now been enrolled in the UCSF clinical trial and both have completed their course of prenatal enzyme replacement therapy. The first patient gave birth in late October 2022, and the second will deliver in early November 2022. Both are doing well.

"It's exciting to continue this research, which is an important step in the evolution of fetal therapy, from surgery for anatomic conditions to medical therapies for genetic conditions," said MacKenzie.

Medical Xpress, 10 November 2022

https://medicalxpress.com

CRISPR cancer trial success paves the way for personalized treatments

2022-11-10

A small clinical trial has shown that researchers can use CRISPR gene editing to alter immune cells so that they will recognize mutated proteins specific to a person's tumours. Those cells can then be safely set loose in the body to find and destroy their target.

It is the first attempt to combine two hot areas in cancer research: gene editing to create personalized treatments, and engineering immune cells called T cells so as to better target tumours. The approach was tested in 16 people with solid tumours, including in the breast and colon.

"It is probably the most complicated therapy ever attempted in the clinic," says study co-author Antoni Ribas, a cancer researcher and physician at the University of California, Los Angeles. "We're trying to make an army out of a patient's own T cells."

"Most complicated therapy ever" tailors bespoke, genome-edited immune cells to attack tumours.

The results were published in Nature1 and presented at the Society for Immunotherapy of Cancer meeting in Boston, Massachusetts on 10 November.

Tailored treatments

Ribas and his colleagues began by sequencing DNA from blood samples and tumour biopsies, to look for mutations that are found in the tumour but not in the blood. This had to be done for each person in the trial. "The mutations are different in every cancer," says Ribas. "And although there are some shared mutations, they are the minority."

The researchers then used algorithms to predict which of the mutations were likely to be capable of provoking a response from T cells, a type of white blood cell that patrols the body looking for errant cells. "If [T cells] see something that looks not normal, they kill it," says Stephanie Mandl, chief scientific officer at PACT Pharma in South San Francisco, California, and a lead author on the study. "But in the patients we see in the clinic with cancer, at some point the immune system kind of lost the battle and the tumour grew."

After a series of analyses to confirm their findings, validate their predictions and design proteins called T-cell receptors that are capable of recognizing the tumour mutations, the researchers took blood samples from each participant and used CRISPR genome editing to insert the receptors into their T cells. Each participant then had to take medication to reduce the number of immune cells they produced, and the engineered cells were infused.

"This is a tremendously complicated manufacturing process," says Joseph Fraietta, who designs T-cell cancer therapies at the University of Pennsylvania in Philadelphia. In some cases, the entire procedure took more than a year.

Each of the 16 participants received engineered T cells with up to three different targets. Afterwards, the edited cells were found circulating in their blood, and were present in higher concentrations than non-edited cells near tumours. One month after treatment, five of the participants experienced stable disease, meaning that their tumours had not grown. Only two people experienced side effects that were likely due to the activity of the edited T cells.

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Although the efficacy of the treatment was low, the researchers used relatively small doses of T cells to establish the safety of the approach, says Ribas. "We just need to hit it stronger the next time," he says.

And as researchers develop ways to speed up the therapies' development, the engineered cells will spend less time being cultured outside of the body and could be more active when they are infused. "The technology will get better and better," says Fraietta.

A solid start

Engineered T cells — called CAR T cells — have been approved for the treatment of some blood and lymph cancers, but solid tumours have posed a particular challenge. CAR T cells are effective only against proteins that are expressed on the surface of tumour cells. Such proteins can be found across many blood and lymph cancers, which means there is no need to design new T-cell receptors for each person with cancer.

But common surface proteins have not been found in solid tumours, says Fraietta. And solid tumours provide physical barriers to T cells, which must circulate through the blood, travel to the tumour and then infiltrate it to kill the cancer cells. Tumour cells also sometimes suppress immune responses, both by releasing immune-suppressing chemical signals and by using up the local supply of nutrients to fuel their rapid growth.

"The environment around a tumour is like a sewer," says Fraietta. "T cells are rendered less functional as soon as they hit the site."

With this initial proof-of-concept in hand, Mandl and her colleagues hope to be able to engineer T cells not only to recognize cancer mutations, but also to be more active near the tumour. Mandl says there are several potential ways to toughen up T cells, for example by removing the receptors that respond to immunosuppressive signals, or by tweaking their metabolism so that they can more easily find an energy source in the tumour environment.

Such elaborate designs could be feasible thanks to recent technological advances in using CRISPR to edit T cells, says Avery Posey, who studies cell and gene therapies for cancer treatment at the University of Pennsylvania in Philadelphia. "It's become incredibly efficient," he says. "We'll see very sophisticated means of engineering immune cells within the next decade."

Nature, 10 November 2022

https://nature.com

Egg whites can be transformed into a material capable of filtering microplastics from seawater

2022-11-04

Researchers at Princeton Engineering have found a way to turn your breakfast food into a new material that can cheaply remove salt and microplastics from seawater.

The researchers used egg whites to create an aerogel, a lightweight and porous material that can be used in many types of applications, including water filtration, energy storage, and sound and thermal insulation. Craig Arnold, the Susan Dod Brown Professor of Mechanical and Aerospace Engineering and vice dean of innovation at Princeton, works with his lab to create new materials, including aerogels, for engineering applications.

One day, sitting in a faculty meeting, he had an idea.

"I was sitting there, staring at the bread in my sandwich," said Arnold. "And I thought to myself, this is exactly the kind of structure that we need." So he asked his lab group to make different bread recipes mixed with carbon to see if they could recreate the aerogel structure he was looking for. None of them worked quite right initially, so the team kept eliminating ingredients as they tested, until eventually only egg whites remained.

"We started with a more complex system," Arnold said, "and we just kept reducing, reducing, reducing, until we got down to the core of what it was. It was the proteins in the egg whites that were leading to the structures that we needed."

Egg whites are a complex system of almost pure protein that—when freeze-dried and heated to 900 degrees Celsius in an environment without oxygen—create a structure of interconnected strands of carbon fibers and sheets of graphene. In a paper published Aug. 24 in Materials Today, Arnold and his coauthors showed that the resulting material can remove salt and microplastics from seawater with 98% and 99% efficiency, respectively.

"The egg whites even worked if they were fried on the stove first, or whipped," said Sehmus Ozden, first author on the paper. Ozden is a former postdoctoral research associate at the Princeton Center for Complex Materials and now a scientist at Aramco Research Center. While regular store-bought egg whites were used in initial tests, Ozden said, other similar commercially available proteins produced the same results.

Egg whites are a complex system of almost pure protein.

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"Eggs are cool because we can all connect to them and they are easy to get, but you want to be careful about competing against the food cycle," said Arnold. Because other proteins also worked, the material can potentially be produced in large quantities relatively cheaply and without impacting the food supply. One next step for the researchers, Ozden noted, is refining the fabrication process so it can be used in water purification on a larger scale.

If this challenge can be solved, the material has significant benefits because it is inexpensive to produce, energy-efficient to use and highly effective. "Activated carbon is one of the cheapest materials used for water purification. We compared our results with activated carbon, and it's much better," said Ozden. Compared with reverse osmosis, which requires significant energy input and excess water for operation, this filtration process requires only gravity to operate and wastes no water.

While Arnold sees water purity as a "major grand challenge," that is not the only potential application for this material. He is also exploring other uses related to energy storage and insulation.

The research included contributions from the departments of chemical and biological engineering and geosciences at Princeton and elsewhere. "It's one thing to make something in the lab," said Arnold, "and it's another thing to understand why and how." Collaborators who helped answer the why and how questions included professors Rodney Priestley and A. James Link from chemical and biological engineering, who helped identify the transformation mechanism of the egg white proteins at the molecular level. Princeton colleagues in geosciences assisted with measurements of water filtration.

Susanna Monti of the Institute for Chemistry of Organometallic Compounds and Valentina Tozzi from Instituto Nanoscienze and NEST-Scuola Normale Superiore created the theoretical simulations that revealed the transformation of egg white proteins into the aerogel.

Phys Org, 4 November 2022

https://phys.org

Particles in the air tied to sudden heart attacks

2022-11-04

Published in The Lancet Public Health, this finding, which is based on data collected between 2010 and 2018, resolves the uncertainty

that inconsistencies in earlier studies caused due to limitations in the availability and quality of environmental and disease data.

The study team, which was made up of members from the National Environment Agency's Environmental Health Institute and the Environmental Monitoring and Modelling Division of the Clean Environment Group at Duke-NUS Medical School, assessed whether there was a correlation between out-of-hospital cardiac arrests (OHCA) and the levels of tiny air pollution particles that are at least 25 times smaller than the width of a human hair.

This PM2.5 category of particulate matter is known from previous research to significantly increase the risk of cardiovascular, respiratory, and even ocular diseases.

"We have produced clear evidence of a short-term association of PM2.5 with out-of-hospital cardiac arrest, which is a catastrophic event that often results in sudden death," says Joel Aik, lead investigator of the study and adjunct assistant professor from Duke-NUS' Pre-Hospital & Emergency Research Centre (PERC).

This study, which follows a methodology similar to that used in studies referenced by the World Health Organization to set air quality guidelines, based its findings on data reported to the Pan-Asian Resuscitation Outcomes Study (PAROS) on all cases of OHCA in Singapore between July 1, 2010, and December 31, 2018. The timing of these cases was compared with the daily air pollutant levels over the same period.

Statistical analysis identified 492 out of 18,131 OHCA events that the researchers were able to attribute to an increase in PM2.5 concentrations either on the day of the cardiac arrest or up to two days before. The study also identified a clear reduction in risk from three to five days after exposure to the pollutant, suggesting a relatively short-term effect.

The average PM2.5 concentration during the study period was 18.44 micrograms per cubic meter, and a decrease of just one microgram resulted in an 8% reduction in the number of OHCA events, while a decrease of three micrograms brought a 30% reduction.

"These results make it clear that efforts to reduce the levels of air pollution particles in the 2.5 micrograms or lower range, and steps to protect against exposure to these particles, could play a part in reducing sudden cardiac arrests in Singapore's population, while also reducing the burden

Small particles in air pollution in Singapore might have caused sudden cardiac arrests in some people who were not in the hospital but simply going about their normal lives.

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on health services," says Aik, who is also an environmental epidemiologist with the NEA.

He emphasizes the relevance of this research to many cities around the world where air pollution is an everyday problem. Less common but extreme events, such as haze and wildfires, can also lead to sudden and dramatic increases in PM2.5 particles. Despite the consistency in study findings with those elsewhere, and a biologically plausible mechanism of effect of PM2.5 on OHCA events, he cautions that this was an observational study and does not imply direct causation.

"This study provides strong evidence for the impact of air quality on health and should stimulate policy and ground efforts to manage emissions from key sources that can lead to PM2.5 increases and prevent potential harm to public health," says Marcus Ong, director of the Health Services & Systems Research Programme and PERC at Duke-NUS and chairman of PAROS. "New policy interventions, such as phasing out internal combustion engine vehicles, can help to reduce the dangers."

Ong, who is also senior consultant at the emergency medicine department of at Singapore General Hospital, adds, "Individuals can also take simple but significant steps, such as wearing high efficiency air filtration masks during periods when the PM2.5 levels are elevated and not smoking."

Futurity, 4 November 2022

https://futurity.org

They made a material that doesn't exist on Earth. That's only the start of the story.

2022-11-09

It sounds like the plot of a science fiction movie: humans are destroying the Earth, gouging huge scars in its crust, and polluting the air and the ground as they mine and refine a key element essential for technological advance. One day, scientists examining an alien meteorite discover a unique metal that negates the need for all that excavation and pollution. Best of all, the metal can be replicated, in a laboratory, using base materials. The world is saved!

OK, we amped the story a wee bit there. No aliens, for one thing (unless you know something we don't). But the rest of it is true. Two teams of scientists — one at Northeastern University in Boston; the other at the University of Cambridge in the UK — recently announced that they

The compound is so tough that manufacturers could make permanent magnets out of it for all but the most demanding pieces of machinery.

managed to manufacture, in a lab, a material that does not exist naturally on Earth. It — until now — has only been found in meteorites.

We spoke to Laura Henderson Lewis, one of the professors on the Northeastern team, and she told us the material found in the meteorites is a combination of two base metals, nickel and iron, which were cooled over millions of years as meteors tumbled through space. That process created a unique compound with a particular set of characteristics that make it ideal for use in the high-end permanent magnets that are an essential component of a vast range of advanced machines, from electric vehicles to space shuttle turbines.

The compound is called tetrataenite, and the fact that scientists have found a way to make it in a lab is a huge deal. If synthetic tetrataenite works in industrial applications, it could make green energy technologies significantly cheaper. It could also roil the market in rare earths, currently dominated by China, and create a seismic shift in the industrial balance between China and the West.

Earthly, yet oh, so rare

As all of our readers will doubtless remember from their high school science classes, magnets are an essential component of any piece of machinery that runs on electricity: they are the conduit that transforms electric power into mechanical action.

Most magnets, like the magnet in the battery-powered clock on your office wall, for example, are pretty cheap and easy to produce. The so-called permanent magnets that are used in advanced machinery, on the other hand, have to be able to resist tremendous pressures and temperatures for long periods of time. And to acquire those properties, they need a special ingredient: a rare earth.

Rare earths aren't that rare. They're elements that can be found all over the world. The difficult part is extracting them. For one thing, you have to dig them out of the ground. That's hard enough. Then you have to separate them out: they're usually combined with other elements or materials. Breaking these compounds down, and refining them to get the raw elements, is an expensive and messy business.

The China syndrome

The US used to be a leader in the rare earths world, but, in the 1980s, China found a huge deposit of these elements within its borders. Jonathan

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Hykawy is president of Stormcrow Capital, an investment firm that tracks rare earths markets. He has a good story about this discovery.

"A few Chinese companies opened mines in inner Mongolia and they were iron ore mines, and they were producing a waste material that ended up in their tailings piles," Hykawy says. "The Japanese were buying large quantities of this iron, and they said, 'Can we sample the waste piles?' And the Chinese said, 'Sure, take all you want.' The Japanese came back a little while later and said, 'We'd like to buy the waste.' And the Chinese said, 'Well, why wouldn't we sell it to you? I mean, it's waste. What are we going to do with it?' Turns out it was rich in rare earths."

The Chinese caught on pretty quickly, and began extracting these rare elements themselves. They could do it a lot more cheaply than anyone else, because their labor costs were a lot lower, and they were willing to put up with the environmental costs, which were not insignificant. Pretty soon, Hykawy says, US production ceased, and China effectively took over the market. Today, China controls more than 71% of the world's extraction and 87% of the world's processing capacity of rare earths.

Two of these rare earths, neodymium and praseodymium, are key components in the manufacturing of permanent magnets, which means that China now dominates the permanent magnet market, too, making more than 80 percent of these high-end instruments. A decade ago, this didn't seem to be a problem. China was a willing and cooperative trading partner, apparently so unthreatening that in 2004 the US actually outsourced the production of magnets used in the guidance systems for American cruise missile and precision bombs to a Chinese company.

"We had US production," Laura Lewis says. "Magnaquench, a subsidiary of General Motors. It was in Anderson, Indiana, and it went wholesale over to China. It was a short-term view of economics; profit up front, but then we lost our capabilities down the road."

Today, relations with China are more fraught. And the need for both rare earths and permanent magnets is increasing, as we move to a clean-energy economy.

The US has awoken to the realization that it is at a significant strategic disadvantage to China in this vital area for its economy and national security. It has restarted an idled rare earths mine in California, and it is looking at potential new mining sites in Arizona, Nevada, and Wyoming. But those mines will take more than a decade to come online.

Game changer

This is why the discovery of synthetic tetrataenite is so exciting, Jonathan Hykawy says. The compound is so tough that manufacturers could make permanent magnets out of it for all but the most demanding pieces of machinery. If that happens, the US could fill a huge part of the magnet market itself, and reduce its need for certain rare earths. And it would make for a huge shift in America's relationship with China. No longer would the US be beholden to a competitor for these key materials or dependent on them for certain parts essential for the production of vital technology.

There is a potential downside, however. Rare earths aren't just used in the production of permanent magnets. They're used in fiber optics, in radiation scanners, in televisions, in personal electronics. If a big part of the rare earths market disappears because of tetrataenite, Hykawy says, the production of all of these other important rare earths could be disrupted. They could become significantly more expensive to produce, which could drive up the cost of a range of consumer and industrial goods.

Far out

But it will be a long time before tetrataenite is in a position to disrupt any existing markets, Laura Lewis says. She says there is still a lot of testing to be done to find out whether lab tetrataenite is as hardy and as useful as the outer space material. And even if it turns out to be as good, it will be five to eight years "pedal to the metal" before anyone could make permanent magnets out of it.

In the meantime, China's competitors are working hard to source rare earths of their own. The US is investing in mines in Australia; there's exploration ongoing in Malaysia, and the Japanese are researching ways to extract elements from mud mined from the sea bed. Jonathan Hykawy says if countries are willing to invest in rare earth extraction, and tolerate the environmental implications, there's no reason they can't level the playing field with China.

"If we were willing to pay enough to produce these things, you can overcome those issues and you can produce these things in an environmentally responsible manner, " he says. "This is no worse than mining and producing aluminum, for example."

OPB, 9 November 2022

https://opb.org

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The Thinking Undead: How Dormant Bacteria Comes Back to Life

2022-11-07

Some bacteria go into a dormant state where their life processes cease when they face starvation and stressful conditions. These cells, known as spores, can resist punishing extremes of heat, pressure, and even the harsh environment of space by entering a deep dormancy.

When the right circumstances arise, spores that may have been dormant for years may eventually awaken and spring back to life within minutes.

Spores awaken by rehydrating and restarting their metabolism and physiology. But up until this point, scientists were unsure whether spores could monitor their surroundings while still "in their sleep" without waking up. It was unknown, in particular, how spores respond with ambiguous environmental signals that do not indicate clearly favorable conditions. Would spores just disregard such mixed conditions or take note?

Biologists from the University of California, San Diego have solved this mystery in a recent study that was published in the journal Science. Researchers from the School of Biological Sciences revealed that spores had an extraordinary ability to evaluate their surroundings despite remaining physiologically dead. They discovered that spores employ stored electrochemical energy to detect if conditions are suitable for a return to normal functioning life, much like a capacitor.

"This work changes the way we think about spores, which were considered to be inert objects," said Gürol Süel, a professor in the Department of Molecular Biology. "We show that cells in a deeply dormant state have the ability to process information. We discovered that spores can release their stored electrochemical potential energy to perform a computation about their environment without the need for metabolic activity."

Many bacterial species form spores—partially dehydrated cells surrounded by a resilient protective coat—as a survival strategy that allows them to remain dormant for thousands of years. Such a remarkable capability makes them a threat in the form of bacterial anthrax as well as a contamination hazard in medicine and the food industry.

Süel and his colleagues tested whether dormant Bacillus subtilis spores could sense short-lived environmental signals that were not strong enough to trigger a return to life. They found that spores were able to

Unexpected bacterial cell activity provides insights about life in extreme states on Earth and maybe on other worlds.

count such small inputs and if the sum reached a certain threshold, they would decide to exit the dormant state and resume biological activity.

Developing a mathematical model to help explain the process, the researchers discovered that spores use a mechanism known as integrate-and-fire, based on fluxes of potassium ions for appraising the surrounding environment. They found that spores responded to even short-lived favorable signals that were not enough to trigger an exit from dormancy. Instead of waking up, spores released some of their stored potassium in response to each small input and then summed consecutive favorable signals to determine if conditions were suitable for exiting. Such a cumulative signal processing strategy can reveal whether external conditions are indeed favorable, and prevents spores from "jumping the gun" into a world of unfavorable conditions.

"The way spores process information is similar to how neurons operate in our brain," said Süel. "In both bacteria and neurons, small and short inputs are added up over time to determine if a threshold is reached. Upon reaching the threshold spores initiate their return to life, while neurons fire an action potential to communicate with other neurons." Interestingly, spores can perform this signal integration without requiring any metabolic energy, while neurons are among the most energy-dependent cells in our bodies.

The researchers believe the new information about spores reframes popular ideas about cells in extremely dormant states that seem dead. Such findings hold implications for evaluating life on objects such as meteors as well as space missions seeking evidence of life.

"This work suggests alternate ways to cope with the potential threat posed by pathogenic spores and has implications for what to expect from extraterrestrial life," said Süel, who holds affiliations with the San Diego Center for Systems Biology, BioCircuits Institute and Center for Microbiome Innovation. "If scientists find life on Mars or Venus, it is likely to be in a dormant state and we now know that a life form that appears to be completely inert may still be capable of thinking about its next steps."

Sci Tech Daily, 7 November

https://scitechdaily.com

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New charging approach could extend battery life by at least 20%

2022-11-07

The many cells that make up a lithium battery pack are not all equal; some will degrade and die faster than others. New research out of Stanford has found that the whole battery can live much longer if each cell gets an individual charging treatment.

There are many reasons why individual cells in a pack might become weaker than others. Maybe there's variances in manufacturing or materials. Maybe some are more exposed to heat sources than others, or located in spots that are harder to cool. Either way, the average single battery cell lasts longer than the average battery pack, and it's these weak cells that take the whole ship down with them.

"If not properly tackled, cell-to-cell heterogeneities can compromise the longevity, health, and safety of a battery pack and induce an early battery pack malfunction," says Simona Onori, an assistant professor of energy science engineering at the Stanford Doerr School of Sustainability, and author on a new study aiming to keep lithium battery packs useful for longer.

Fast charging and discharging events are stressful for battery cells, and while they're designed to take that stress, these are the moments in which weaker cells suffer and deteriorate the fastest. So the Stanford team wondered whether the standard technique of charging all a battery's cells at the same rate might be accelerating battery death.

The researchers painstakingly designed a computer model to test their theory over an accelerated time frame, resulting in what they believe is an unprecedented level of simulation detail. They attempted to accurately represent the physical and chemical state of a battery, as well as the changes that occur in relation to a range of stresses across its whole lifespan, including both changes that happen in seconds, all the way up to others that might take months or years.

"To the best of our knowledge, no previous study has used the kind of high-fidelity, multi-timescale battery model we created," says Onori.

Using this model, they ran a number of simulations comparing a standard, set-rate charging approach against other approaches, in which each individual cell's capacity served as an indicator of how much charge it could take. The theory here was that only the strongest cells should be

Every cell in a battery pack is different, and deteriorates at a different rate. New research finds charging them differently can significantly extend the life of your entire pack.

subjected to the highest stresses; cells that had already begun to degrade early – for whatever reason – should be treated much more gently, in the hope of staving off their eventual decline.

The team found that by individually setting the charge rate of each cell, they could minimize temperature increase and cell degradation, to the point where these packs could handle at least 20% more charge/discharge cycles than a battery that charges uniformly – even using frequent fast-charging.

The drawbacks here are fairly obvious; if you're fast-charging your EV or phone battery, you want it to charge as fast as possible, so you can get back to whatever you're doing, and under a model like this, a certain number of cells in your battery simply wouldn't be charging as fast as they would normally. If you see your batteries as more or less disposable items, and your cars as something that gets replaced every few years, you can see how plenty of consumers wouldn't care if they're accelerating the death of their battery packs. It's somebody else's problem.

On the other hand, it's not like you're generally fast-charging all the way to 100% when you're in a hurry, and the majority of cells in the majority of batteries are just fine, and capable of taking a fast charge. So the difference in the state of charge at the end of half an hour on a supercharger might not be hugely different under this charging model, and if batteries can be coaxed into a longer useful life, that's better for everybody – particularly given the lithium squeeze that's projected to put pressure on decarbonization efforts in the coming decades.

The researchers say their charging model can be easily rolled out through existing electric vehicle designs, or used to guide the development of next-gen battery management systems. They also suggest the same model could be applied to the discharge cycle, asking less from weaker cells and more from stronger ones, for further benefits to the lifespan of any battery pack that gets subjected to high stress loads. Indeed, one of the study authors is now working as a battery researcher at eVTOL developer Archer Aviation.

"Lithium-ion batteries have already changed the world in so many ways," says Onori. "It's important that we get as much as we possibly can out of this transformative technology and its successors to come."

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The study is published in the journal IEEE Transactions on Control Systems Technology.

New Atlas, 7 November 2022

https://newatlas.com

Gene Therapy Can Restore Night Vision After Decades of Congenital Blindness

2022-11-08

According to researchers at the Scheie Eye Institute at the Perelman School of Medicine at the University of Pennsylvania, adults with a genetic form of childhood-onset blindness experienced remarkable recoveries of night vision within days of receiving an experimental gene therapy.

The patients had Leber Congenital Amaurosis (LCA), a congenital blindness caused by GUCY2D gene mutations. The findings were published in the journal iScience. The researchers administered AAV gene therapy, which contains the DNA of the healthy form of the gene, into the retina of one eye for each of the patients in line with the clinical trial protocol. Each patient had significant gains in rod-type photoreceptor cell-mediated visual functions in the treated eye within days after treatment. The majority of the human eye's ability to see in low light comes from rod cells, which are very light-sensitive.

"These exciting results demonstrate that the basic molecular machinery of phototransduction remains largely intact in some cases of LCA, and thus can be amenable to gene therapy even after decades of blindness," said study lead author Samuel G. Jacobson, MD, Ph.D., a professor of Ophthalmology at Penn.

One in every 40,000 newborns is born with LCA, which is one of the most frequent congenital blindness conditions. While the extent of vision loss might vary from patient to patient with LCA, all such individuals experience substantial visual impairment starting in the first few months of life. There are more than two dozen genes whose dysfunction can cause LCA.

Up to 20 percent of LCA cases are caused by mutations in GUCY2D, a gene that encodes a key protein needed in retinal photoreceptor cells for the "phototransduction cascade"—the process that converts light to neuronal signals. Prior imaging studies have shown that patients with this form of LCA tend to have relatively preserved photoreceptor cells, especially in

The patients had some, although severely diminished, visual function during the day, however, at night they were essentially blind, with light sensitivity 10,000–100,000 times less than normal.

rod-rich areas, hinting that rod-based phototransduction could work again if functional GUCY2D were present. Early results with low doses of the gene therapy, reported last year, were consistent with this idea.

The researchers used higher doses of the gene therapy in two patients, a 19- year-old man and a 32-year-old woman, who had particularly severe rod-based visual deficits. In daylight, the patients had some, albeit greatly impaired, visual function, but at night they were effectively blind, with light sensitivity on the order of 10,000 to 100,000 times less than normal.

The researchers administered the therapy to just one eye in each patient, so the treated eye could be compared to the untreated eye to gauge treatment effects. The retinal surgery was performed by Allen C. Ho, MD, a professor of Ophthalmology at Thomas Jefferson University and Wills Eye Hospital. Tests revealed that, in both patients, the treated eyes became thousands of times more light-sensitive in low-light conditions, substantially correcting the original visual deficits. The researchers used, in all, nine complementary methods to measure the patients' light sensitivity and functional vision. These included a test of room navigation skills in low-light conditions and a test of involuntary pupil responses to light. The tests consistently showed major improvements in rod-based, low-light vision, and the patients also noted functional improvements in their everyday lives, such as "can [now] make out objects and people in the dark."

"Just as striking was the rapidity of the improvement following therapy. Within eight days, both patients were already showing measurable efficacy," said study co-author Artur V. Cideciyan, Ph.D., a research professor of Ophthalmology at Penn.

To the researchers, the results confirm that GUCY2D gene therapy restores rod-based photoreceptor functions—and suggest that GUCY2D–LCA patients with more severe rod-based dysfunction are likely to benefit most dramatically from the therapy. The practical message is that there should be an emphasis on rod vision measurements at the screening of LCA candidates and in monitoring them throughout a treatment trial.

The findings, the researchers said, also underscore the remarkable fact that in some patients with severe congenital vision loss, the retinal cell networks that mediate vision remain largely alive and intact, and need

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only the resupply of a missing protein to start working again, more or less immediately.

Sci Tech Daily, 8 November 2022

https://scitechdaily.com

250% Increased Risk – A New Study Adds to the List of Risk Factors for Dementia

2022-11-09

According to a review of the existing evidence conducted by University College London researchers, people with psychotic disorders like schizophrenia are 2.5 times more likely than those without a psychotic disorder to eventually develop dementia.

The recent systematic review and meta-analysis, which was published in the journal Psychological Medicine, indicated that psychotic disorders may be more closely related to dementia than other mental disorders such as depression or anxiety.

Senior author Dr. Jean Stafford (MRC Unit for Lifelong Health & Ageing at UCL) said: "We found that having a diagnosis of a psychotic disorder is linked to a much higher risk of developing dementia later in life. Our findings add to evidence that protecting people's mental health throughout life could help to prevent dementia."

Psychotic disorders can increase your risk of dementia by 250%.

The study is the first high-quality systematic review looking at a range of psychotic disorders and their association with dementia risk. Schizophrenia and other related psychotic disorders are severe illnesses that involve symptoms such as hallucinations and delusions, and social withdrawal. Many people also experience impairments in cognitive and functional skills.

The researchers compiled data from 11 studies that were conducted in nine different nations across four continents with a combined total of over 13 million participants.

They discovered that regardless of the age at which someone initially had their mental illness, there was a greater risk of dementia later in life across multiple psychotic disorders. Some studies involved individuals diagnosed with psychotic disorders as young adults, with decades of follow-up. Additionally, they discovered that individuals with a history of psychotic disorders are much more likely to get a dementia diagnosis when they are still in their 60s.

The findings add to the list of modifiable risk factors for dementia. UCL researchers have previously found that four in 10 dementia cases could be prevented or delayed by targeting risk factors from across the lifespan. The current study's joint senior author, Dr. Vasiliki Orgeta (UCL Psychiatry), previously found that PTSD increases the likelihood of dementia, and while depression and anxiety also increase the risk, these latest findings suggest that psychotic disorders have the strongest association with dementia risk.

The researchers were not able to confirm the cause of the association, whether it is due to the mental illness itself, or perhaps because psychotic disorders increase the likelihood of conditions that in turn increase the risk of dementia. Some of the association may be because psychotic symptoms could be early markers of dementia for some people, but the fact that some of the studies had very long follow-up periods and included people experiencing psychosis at young ages suggests this is not the only explanation.

Dr. Orgeta said: "People with psychotic disorders are more likely to have other health conditions such as cardiovascular disease or obesity, which can increase the risk of dementia, while they are also more likely to have a poor diet, smoke or use drugs, which may harm their health in ways that could increase their likelihood of developing dementia."

Lead author Sara El Miniawi (UCL Psychiatry), who completed the research as her MSc dissertation, said: "Cognitive impairment and hallucinations can be symptoms of both dementia and psychotic disorders, so it is possible there could be a link between the two illnesses. This impairment could also limit people's cognitive reserve, and increase their vulnerability to dementia symptoms."

The researchers were not able to determine whether effective treatment for psychotic disorders could mitigate the dementia risk, or whether antipsychotic medication could be a factor, as there was limited and conflicting evidence.

Sara El Miniawi added: "As people with psychotic disorders face a higher risk of numerous other health conditions, managing their overall physical and mental health is very important, and here we found that health

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professionals working with them should also be watchful for any signs of cognitive decline."

Sci Tech Daily, 9 November 2022

https://scitechdaily.com

Liquid-metal tech could allow implants to be dissolved instead of removed

2022-11-10

Currently, small metal implants either have to be surgically removed from the body once they're no longer needed, or just left inside indefinitely – both of which can lead to complications. Now, however, scientists have devised a method of breaking them down in place using liquid metal.

Led by Asst. Prof. Giovanni Traverso and postdoctoral researcher Vivian Feig, a team at MIT drew upon a process known as liquid metal embrittlement.

In this phenomenon, hard metals such as zinc or stainless steel disintegrate upon contact with certain types of liquid metal. This happens as the liquid metal penetrates the solid metal's grain boundaries, which are the borders between the tiny crystals it's composed of.

Initially, the scientists were looking at harnessing the process in order to break down devices implanted in the gastrointestinal (GI) tract. They knew that a soft metal called gallium works well on hard aluminum, so they experimented with a gallium alloy – eutectic gallium-indium (EGaIn) – along with a partially aluminum drug-delivery device.

That Y-shaped prototype device consisted of medication-filled polymer arms joined to a polymer hub by aluminum connector tubes. The idea was that once it got inserted into a patient's GI tract, it would harmlessly lodge in place and gradually release its drug payload, until it disintegrated and was passed with the feces.

In animal studies, after the device had been put in place in the GI tract, a solution containing EGaIn was orally administered. As the liquid passed over the device, it caused the aluminum connectors to break down, allowing the device to fall apart and be passed. Importantly, rodent studies indicated that EGaIn is non-toxic and biocompatible, although further research has to be conducted on its effect on humans.

It was found that the liquid metal caused aluminum staples to disintegrate in a matter of minutes.

Following their success with the drug-delivery device, the scientists were also able to break down an aluminum stent implanted in esophageal tissue. Moving beyond the GI tract, they then tried painting EGaIn onto aluminum surgical staples of the type used to hold wounds closed – the removal of regular surgical staples, by traditional means, can sometimes actually damage the healed tissue.

It was found that the liquid metal caused the aluminum staples to disintegrate in a matter of minutes. Additionally, if the staples were used in a real-world scenario, the resulting aluminum fragments reportedly wouldn't be a problem.

"For staples, our design is such that the tissue is held together because of a bridge supporting two counterposing legs; if the bridge is dissolved, the legs of the staple can be easily removed," Feig told us. "Alternatively, if there are fragments left inside the tissue, we have observed that they can be easily rinsed out."

The research is described in a paper that was recently published in the journal Advanced Materials.

New Atlas, 10 November 2022

https://newatlas.com

Undetected Black Hole Reveals Itself by Violently Shredding a Star That Strayed Too Close

2022-11-10

After lurking undetected in a dwarf galaxy, an intermediate-mass black hole revealed itself to astronomers when it gobbled up an unlucky star that strayed too close. Known as a "tidal disruption event" or TDE, the violent shredding of the star produced a flare of radiation that briefly outshone the combined stellar light of the host dwarf galaxy. This observation could help scientists better understand the relationships between black holes and galaxies.

The flare was captured by astronomers with the Young Supernova Experiment (YSE), a survey designed to detect cosmic explosions and transient astrophysical events. An international team led by scientists at UC Santa Cruz, the Niels Bohr Institute at the University of Copenhagen, and Washington State University reported the discovery in a paper published today (November 10) in Nature Astronomy.

Scientists hope to improve their understanding of the growth of supermassive black holes in massive galaxies by studying intermediate-mass black holes.

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"This discovery has created widespread excitement because we can use tidal disruption events not only to find more intermediate-mass black holes in quiet dwarf galaxies, but also to measure their masses," said coauthor Ryan Foley, an assistant professor of astronomy and astrophysics at UC Santa Cruz who helped plan the YSE survey.

First author Charlotte Angus at the Niels Bohr Institute said the team's findings provide a baseline for future studies of midsize black holes.

"The fact that we were able to capture this midsize black hole whilst it devoured a star offered us a remarkable opportunity to detect what otherwise would have been hidden from us," Angus said. "What is more, we can use the properties of the flare itself to better understand this elusive group of middle-weight black holes, which could account for the majority of black holes in the centers of galaxies."

Supermassive black holes are found at the centers of all massive galaxies, including our own Milky Way. Astronomers conjecture that these massive beasts, with millions or billions of times the mass of the sun, could have grown from smaller "intermediate-mass" black holes with thousands to hundreds of thousands of solar masses.

One theory for how such massive black holes were assembled is that the early universe was rampant with small dwarf galaxies with intermediate-mass black holes. Over time, these dwarf galaxies would have merged or been gobbled up by more massive galaxies, their cores combining each time to build up the mass in the center of the growing galaxy. This merger process would eventually create the supermassive black holes seen today.

"If we can understand the population of intermediate-mass black holes out there—how many there are and where they are located—we can help determine if our theories of supermassive black hole formation are correct," said coauthor Enrico Ramirez-Ruiz, professor of astronomy and astrophysics at UCSC and Niels Bohr Professor at the University of Copenhagen.

But do all dwarf galaxies have midsize black holes?

"That's difficult to assert, because detecting intermediate-mass black holes is extremely challenging," Ramirez-Ruiz said.

Classic black hole hunting techniques, which look for actively feeding black holes, are often not sensitive enough to uncover black holes in the centers of dwarf galaxies. As a result, only a minuscule fraction of dwarf galaxies is known to host intermediate-mass black holes. Finding more

midsize black holes with tidal disruption events could help to settle the debate about how supermassive black holes form.

"One of the biggest open questions in astronomy is currently how supermassive black holes form," said coauthor Vivienne Baldassare, professor of physics and astronomy at Washington State University.

Data from the Young Supernova Experiment enabled the team to detect the first signs of light as the black hole began to eat the star. Capturing this initial moment was pivotal to unlocking how big the black hole was, because the duration of these events can be used to measure the mass of the central black hole. This method, which until now had only been shown to work well for supermassive black holes, was first proposed by Ramirez-Ruiz and coauthor Brenna Mockler at UC Santa Cruz.

"This flare was incredibly fast, but because our YSE data gave us so much early information about the event, we were really able to pin down the mass of the black hole using it," Angus said.

Sci Tech Daily, 10 November 2022

https://scitechdaily.com

Probiotic 'backpacks' show promise for treating inflammatory bowel diseases

2022-11-11

Like elite firefighters headed into the wilderness to combat an uncontrolled blaze, probiotic bacteria do a better job quelling gut inflammation when they're equipped with the best gear.

A new study by researchers at the University of Wisconsin–Madison demonstrates just how much promise some well-equipped gut-friendly bacteria hold for improving treatments of inflammatory bowel disease (IBD), including Crohn's disease and ulcerative colitis.

Led by Quanyin Hu, a biomedical engineer and professor in the UW–Madison School of Pharmacy, the research builds on technology the team had previously designed. That prior technology encases beneficial bacteria within a very thin protective shell to help them survive an onslaught of stomach acids and competing microbes long enough to establish and multiply in the guts of mice.

The tiny particles are part sulfide and part hyaluronic acid. The acid is powerfully anti-inflammatory, and the sulfide directly targets the reactive oxygen species.

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While the technology makes orally administered probiotics more effective, IBD is a complex disease that usually involves more than gut microbial communities that are out of whack.

"IBD is a complicated disease, and you need to attack it at different angles," says Hu.

So, Hu and his colleagues devised specialized nanoparticles to neutralize molecules implicated in IBD. They've also figured out a way of attaching these nanoparticle "backpacks" to beneficial bacteria after encasing them in the protective coating.

Combined with the probiotics themselves, these nanoparticle backpacks could significantly improve—and simplify—IBD treatments.

While the root causes of IBD are complex and still being studied, one culprit involves the overproduction of molecules known as reactive oxygen species. These molecules are crucial for certain human body functions, but too many of them in the gut can fuel damaging inflammation along the lining of intestines.

Enter the nanoparticle backpacks. The tiny particles are part sulfide and part hyaluronic acid. The acid is powerfully anti-inflammatory, and the sulfide directly targets the reactive oxygen species.

Conducted in mice, Hu's latest research shows that probiotic bacteria Escherichia coli Nissle 1917 encased in a protective shell and outfitted with the nanoparticle backpacks are significantly better at relieving IBD symptoms than their counterparts without the additional gear. The findings were reported Nov. 11 in the journal Science Advances.

The researchers estimated the effects of the treatments in two ways: by measuring changes in weight and changes in the colon length of mice with IBD that did and did not receive the treatment.

Like humans, mice with IBD commonly experience weight loss and colon shortening as the disease progresses. Hu and his colleagues found that mice that received the full treatment experienced the least amount of weight loss and much less colon shortening than their counterparts that received partial or no treatments.

Current treatment options depend on the stage and severity of disease, whereas Hu and his colleagues say they have sought a more holistic treatment that could be effective at any stage.

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"That's the most exciting part of this research for me," says Hu. "We didn't want to target a specific IBD stage. We wanted to select the most important factors that contribute to curing or treating the disease at whatever stage."

Additionally, the treatment is administered orally, which could make it a palatable alternative to other more invasive forms of IBD treatment such as partial or complete remove of the colon.

While the results are promising, it will be some time before the treatments are tested in humans.

Next in Hu's sights is testing whether the nanoparticle backpacks work well with other probiotic bacteria species and documenting whether the treatment has any unwelcome side effects. Simplifying the process of creating and attaching the nano-backpacks will also be crucial for making the treatments clinically feasible.

Medical Xpress, 11 November 2022

https://medicalxpress.com

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Aquatic environmental fates and risks of benzotriazoles, benzothiazoles, and p-phenylenediamines in a catchment providing water to a megacity of China

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