CHEMWATCH

Bulletin Board

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ASIA PACIFIC

Shanghai Customs Heightens Supervision of Dangerous Goods by Means of Big Data

2022-09-14

As the largest import and export channel for dangerous goods packed in containers, Shanghai accounts for around half of China's total import and export volume. Currently, there are more than 6,600 businesses declaring their imports of hazardous chemicals at the Shanghai port, and about 80% of the consignees are enterprises located in the Yangtze River Delta region.

To better facilitate the risk prevention and control of dangerous goods, Shanghai Customs is proceeding to build a collaborative supervision mechanism by means of big data. By giving full play to the role of cross-border commerce big data platform, the bureau has improved its capability to identify risks and conduct targeted countermeasures accurately. Specifically, it has carried out risk analysis on the declaration, storage and transport of hazardous chemicals, built an intelligent risk prevention and control model, and established an automatic categorization and surveillance model for the import and export of precursor chemicals and hazardous chemicals.

According to statistics, as of the end of July this year, Shanghai Customs has supervised a total of 53,000 imported and exported dangerous goods, detected and transferred 107 cases to relevant authorities involving false declarations and inspection evasion, etc. of 3,025 tons of dangerous goods. Through risk analysis, the bureau has inspected 706 cases, of which 128 are false or concealed declarations of dangerous goods.

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Chemlinked, 14-09-22

https://chemical.chemlinked.com/news/chemical-news/shanghai-customs-heightens-supervision-of-dangerous-goods-by-means-of-big-data

Taiwan Proposes 15 Substances as Chemicals of Concern

2022-09-14

Taiwan EPA is consulting on designating 15 chemical substances as "chemical substances of concern", including 2 new psychoactive

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substances, 5 chemicals of food safety concerns and 8 precursors for blasting explosives. The 14-day consultation period will end on September 22, 2022.

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Chemlinked, 14-09-22

https://chemical.chemlinked.com/news/chemical-news/taiwan-proposes-15-substances-as-chemicals-of-concern

Vietnam RoHS: Four Phthalates to Be Restricted in Electrical and Electronic Equipment

2022-09-13

On August 19, 2022, Vietnam's Ministry of Industry and Trade (MoIT) released a circular on the draft of a new RoHS (Restriction of hazardous substances) regulation called National Technical Regulation on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment. If adopted, this regulation will take effect from January 1, 2026, replacing the existing RoHS regulation (Circular No.30/2022/TT-BCT). The draft is open for consultation until October 17, 2022.

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Chemlinked, 13-09-22

https://chemical.chemlinked.com/news/chemical-news/vietnam-rohs-four-phthalates-to-be-restricted-in-electrical-and-electronic-equipment

Taiwan makes 'extensive' updates to guidelines on children's cosmetics

2022-09-06

Taiwan's FDA has updated its guidelines for children's cosmetics to include several new labelling recommendations aimed at improving product safety.

Published on 17 August, the updates to the Safety Guidelines for Cosmetics for Children are "extensive" compared with the original version published in 2016, said Chia-Sui Hsu, regulatory manager at Global Product Compliance (GPC).

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Chemical Watch, 06-09-22

https://chemicalwatch.com/556123/taiwan-makes-extensive-updates-to-guidelines-on-childrens-cosmetics

AMERICA

As concerns about PFAS rise, doctors scramble to learn about the toxic chemicals

2022-09-15

A major report from the National Academies recommended that individuals with significant exposure to toxic chemicals, known as PFAS, get a blood test and ongoing medical monitoring. The guidance covers a wide range of people, including those who live near commercial airports, military bases and farms where sewage sludge may have been used.

Yet, many doctors don't know how to order a PFAS blood test — nor how to interpret the results when the test is done.

"Clinicians in the state are really at a loss. And I'm sure people are asking left and right to have this test," said Brita Lundberg, chair of the Environmental and Occupational Health Committee at the Massachusetts Medical Society. "We've had our own members approach us saying, 'what should we be doing here?'"

Lundberg is drafting a resolution that, she said, would help her organization advocate on PFAS at the statehouse and with the American Medical Association.

As physicians begin to field more questions about PFAS chemicals — which are ubiquitous and associated with a host of health concerns — there are new efforts to get the medical community up to speed on the topic. But there's also pushback, as some experts question whether blood testing is the best approach.

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WBUR, 15-09-22

https://www.wbur.org/news/2022/09/05/forever-chemicals-pfas-pfoa-medicine-blood-tests

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USDA Publishes ANPR on Inert Ingredients in Pesticides for Organic Production

2022-09-14

On September 2, 2022, the U.S. Department of Agriculture (USDA) Agricultural Marketing Service (AMS) published an advance notice of proposed rulemaking (ANPR) seeking input from stakeholders about how to update its organic regulations on inert ingredients in pesticides used in organic production. 87 Fed. Reg. 54173. AMS seeks comments on alternatives to its existing regulations that would align with the Organic Foods Production Act of 1990 (OFPA) and the U.S. Environmental Protection Agency's (EPA) regulatory framework for inert ingredients. According to the ANPR, information from public comments would inform AMS's approach to this topic, including any proposed revisions of the USDA organic regulations. Comments are due November 1, 2022.

According to AMS, the ANPR seeks input from stakeholders about how to rectify the USDA organic regulations' references to outdated EPA policy on inert ingredients used in pesticide products. AMS states that the outdated references are inconsistent with current EPA requirements and that this causes problems in the organic industry and for AMS's administration of the USDA organic regulations.

AMS notes that inert ingredients, also identified as "other ingredients" on pesticide labels, are substances other than the "active" (i.e., pesticidal) ingredients included in formulated pesticide products. Inert ingredients may function as adjuvants, solvents, diluents, stabilizers, or preservatives. AMS states that pesticide labels do not typically disclose the identity (common or chemical name) of the inert ingredients in the product.

For organic crop and livestock production, current USDA organic regulations allow EPA List 3 and List 4 inert ingredients to be used in pesticide products when the product includes active ingredients permitted by the organic regulations. According to AMS, together, EPA List 3 and List 4 include more than 2,700 inert ingredients. AMS states that it does not know how many of these inert ingredients are included in products used in organic production, "but it is likely a relatively small subset of these 2,700 ingredients." Because the Food Quality Protection Act of 1996 (FQPA) mandated that EPA develop tolerances (or tolerance exemptions) for inert ingredients used in food-contact products, new and existing inert ingredients are approved for use through EPA's rulemaking process. As a result, EPA no longer updates the EPA lists referenced in the USDA organic regulations.

Read More

FIFRA blog, 14-09-22

https://pesticideblog.lawbc.com/entry/usda-publishes-anpr-on-inert-ingredients-in-pesticides-for-organic-producti

Intel's microchip expansion could fail if Congress bans this crucial set of chemicals

2022-09-12

A severe shortage in computer chips roiled the U.S. economy last year, costing auto manufacturers $210 billion in revenue alone as cars sat in lots waiting for chips to be installed.

Other sectors took hits, too, given that semiconductor are used in everything from computers, smartphones, consumer electronics to appliances and medical equipment.

Luckily for consumers, in response to the shortages, Intel has broken ground on two chip manufacturing plants in Arizona to help secure supply chains and prevent further disruptions. When all is said and done, Chandler will be home to six semiconductor production facilities, employing around 15,000 people.

The size and scope of these investments cannot be understated.

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Azcentral, 12-09-22

https://www.azcentral.com/story/opinion/op-ed/2022/09/12/intel-microchip-production-could-stall-over-misguided-pfas-bill/8037720001/

EUROPE

EUON Publishes Nanopinion on the Transportation of Nanoparticles across the Blood-Brain Barrier

2022-09-14

On September 13, 2022, the European Union (EU) Observatory for Nanomaterials (EUON) published a Nanopinion entitled "Can the Brain's Gatekeeper Fight a Nano-Attack?" by Dr. Eugenia (Éva) Valsami-Jones, Professor of Environmental Nanoscience at the University of Birmingham, who co-authored an article entitled "Biotransformation modulates the

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penetration of metallic nanomaterials across an artificial blood–brain barrier model." The researchers set out to explore systematically how different nanoparticle properties play a role in their potential to be transported across the blood-brain barrier (BBB). To be able to test their hypotheses, they constructed a model BBB inside a special permeable well, on which human cells representative of the BBB were cultured and tested to ensure their function precisely replicated that of the real barrier. The researchers then investigated what factors affect the ability of a number of model nanoparticles, specifically cerium oxide, iron oxide, zinc oxide, and silver in different particle sizes and shapes, to cross the model BBB. Valsami-Jones states that the researchers discovered that silver and zinc oxide nanoparticles, "which are often used in consumer goods, including healthcare products, have the potential to cross the BBB and enter the brain in the form of both particles and dissolved ions, depending on the size, shape and exposure concentration."

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Nano and Other Emerging Chemical Technologies Blog, 14-09-22

https://nanotech.lawbc.com/2022/09/euon-publishes-nanopinion-on-the-transportation-of-nanoparticles-across-the-blood-brain-barrier/

CLP Revision

2022-09-13

What is CLP?

Chemical Hazard communication in the EU is regulated by the Classification, Labelling and Packaging (CLP) Regulation through harmonised criteria for classification of substances and mixtures, and rules on labelling and packaging for hazardous substances and mixtures. CLP is based on the United Nations' Globally Harmonised System (UN GHS). It requires manufacturers, importers or downstream users of substances or mixtures to classify, label and package their hazardous chemicals appropriately before placing them on the market. The information is provided on the label to allow safe use of products, and the design of packaging depends on the hazards of the product it contains.

Revision of CLP is no trivial matter

One of the key changes mulled by the European Commission is to introduce new hazard classes to cover the substances with the following properties: Endocrine Disruptors (ED); Persistent, Bioaccumulative and Toxic (PBT); very Persistent and very Bioaccumulative (vPvB); Persistent,

Mobile and Toxic (PMT) and very Persistent and very Mobile (vPvM) substances.

As a result, chemical manufacturers will need to update labels on packaging, Safety Data Sheets and REACH registration dossiers.

However, the main impact lies with second-order effects of CLP Regulation, so its reform will have far-reaching consequences for all other sectors relying on chemicals. This is what we call a "ripple effect" of chemicals legislation on value chains relying on chemicals.

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CEFIC, 13-09-22

https://cefic.org/policy-matters/clp-revision/

No more mercury in lots of fluorescent tubes

2022-09-07

It will soon be the end of the most common fluorescent tubes at home. It saves the environment and health from many tons of mercury.

The EU has adopted a ban on three very popular fluorescent tubes, which hang in large numbers in Danish office and service companies, agriculture, industry, warehouses, shops, schools and institutions.

The fluorescent tubes are called T5, T8 and CFLni and contain mercury, which is one of the most dangerous environmental toxins available.

The EU itself estimates that the change to the rules will save the environment and health at least three tonnes of mercury by 2035.

Specifically, the new rules mean that from February and August 2023, respectively, it will be prohibited to send new CFLni and T5 and T8 fluorescent tubes on the European market. It is still permitted for dealers to sell out of their stocks after this, just as consumers can continue to buy fluorescent tubes as long as stocks are available and use already purchased fluorescent tubes.

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Mst.dk, 07-09-22

https://mst-dk.translate.goog/service/nyheder/nyhedsarkiv/2022/sep/slut-med-kviksoelv-i-de-mest-brugte-lysstofroer/?_x_tr_sl=auto&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=op,wapp

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INTERNATIONAL

African countries propose international code of conduct for chemicals

2022-09-15

Africa's regional focal point, representing the continent in discussions on the UN's Strategic Approach to International Chemicals Management (Saicm), has proposed the development of an international code of conduct on chemicals and waste management.

The proposal, put forward by the Africa Group at the 29 August–2 September fourth intersessional process (IP4) meeting, calls for a code to be developed in time for the fifth International Conference on Chemicals Management (ICCM5). This takes place from 25–29 September 2023, in Bonn, Germany.

Such a code, the group led by Angola said, should focus on the "basic responsibilities" needed for chemical and waste management, laying out minimum responsibilities and best practices.

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Chemical Watch, 15-09-22

https://chemicalwatch.com/562244/african-countries-propose-international-code-of-conduct-for-chemicals

OECD Publishes New Reports in Series on the Safety of Manufactured Nanomaterials

2022-09-12

The Organization for Economic Cooperation and Development (OECD) Series on the Safety of Manufactured Nanomaterials is to provide up-to-date information on the OECD activities related to human health and environmental safety. In September 2022, OECD has published two new reports. Advanced Materials: Working Description (No. 104) aims to illustrate the content of the advanced materials playing field and the purpose of the Working Party on Manufactured Nanomaterials' (WPMN) engagement regarding these materials. In this context, advanced materials are understood as materials that are rationally designed to have new or enhanced properties and/or targeted or enhanced structural features with the objective to achieve specific or improved functional performance. This includes both new emerging manufactured materials, and materials

that are manufactured from traditional materials. This also includes materials from innovative manufacturing processes that enable the creation of targeted structures from starting materials, such as bottom-up approaches. The report acknowledges that what are currently considered as advanced materials will change with time. The report includes examples of possible cases of advanced materials.

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Nano and Other Emerging Chemical Technologies Blog, 12-09-22

https://nanotech.lawbc.com/2022/09/oecd-publishes-new-reports-in-series-on-the-safety-of-manufactured-nanomaterials/

New tasks, fees on agenda as Commission issues 'call for evidence' on Echa Regulation

2022-09-15

The European Commission has launched a call for evidence ahead of a proposal for a new standalone Regulation to redefine Echa's financing and operating model, which could introduce new fees for industry.

A key plank of the EU's 'better regulation' agenda, the call for evidence outlines the aims and objectives of the new initiative. If approved, the Regulation would supersede the 'agency' chapter in title X of REACH which sets out the way Echa and its committees operate within the law.

The tasks assigned to the agency have increased and become more complex over the years, and this is expected to continue due to a likely increase in the number of existing tasks and new tasks deriving from the implementation of the chemicals strategy for sustainability (CSS), the Commission said.

The new 'basic' Regulation will aim to tackle these difficulties by clarifying the legal framework to make Echa "work more effectively, efficiently and coherently", the EU executive said in the call for evidence.

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Chemical Watch, 15-09-22

https://chemicalwatch.com/565095/new-tasks-fees-on-agenda-as-commission-issues-call-for-evidence-on-echa-regulation

The new 'basic' Regulation will aim to tackle these difficulties by clarifying the legal framework to make Echa "work more effectively, efficiently and coherently"

Janet's Corner

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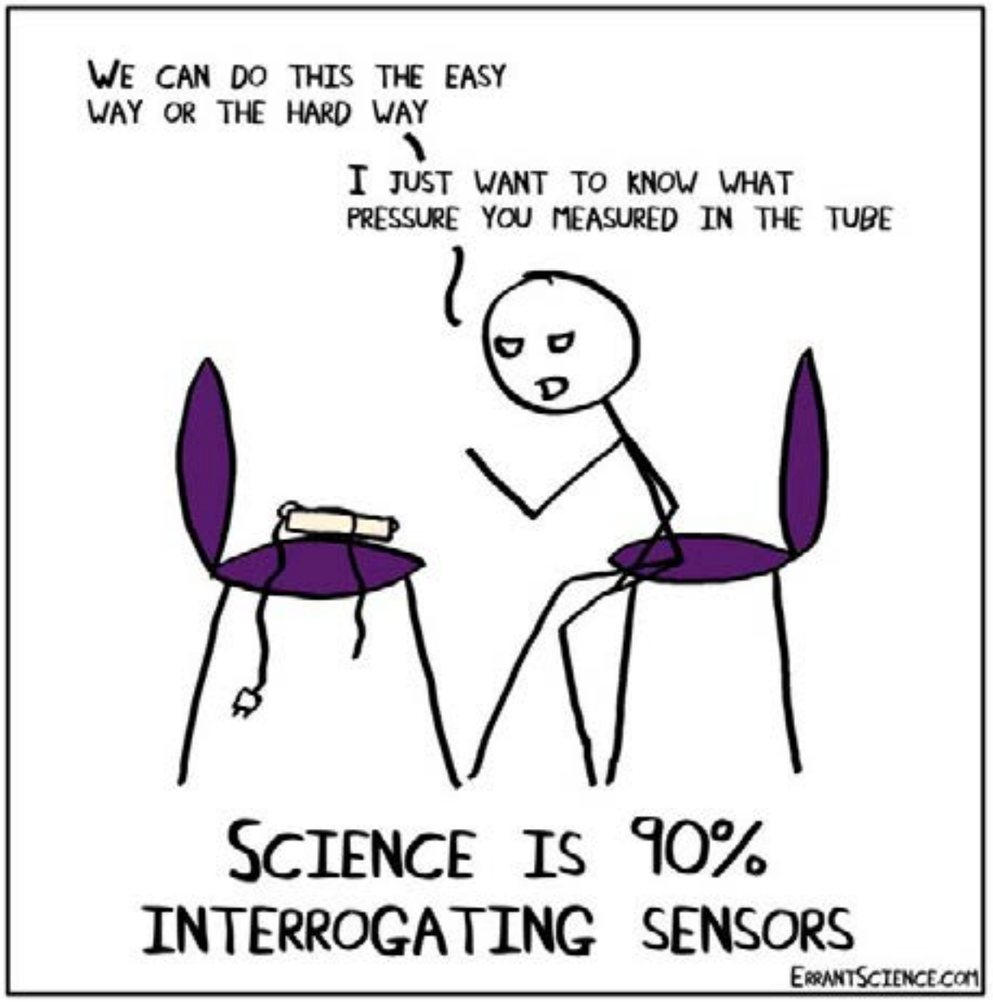
Sensor Interrogation

2022-09-23



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Hazard Alert

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Sodium Hypochlorite

2022-09-23

Sodium hypochlorite is a chemical compound with the formula NaClO. [1] It is a clear, slightly yellowish solution with a characteristic odour. Sodium hypochlorite is unstable. Chlorine evaporates from the solution and when heated, the sodium hypochlorite disintegrates. This also happens when sodium hypochlorite comes in contact with acids, sunlight, certain metals and poisonous and corrosive gasses, including chlorine gas. It is a strong oxidator and reacts with flammable compounds and reductors. Sodium hypochlorite solution is a weak base that is inflammable.[2]

USES [2]

Sodium hypochlorite is used on a large scale. For example in agriculture, chemical industries, paint- and lime industries, food industries, glass industries, paper industries, pharmaceutical industries, synthetics industries and waste disposal industries. In the textile industry sodium hypochlorite is used to bleach textile. It is sometimes added to industrial wastewater. This is done to reduce odours. Hypochlorite neutralises sulphur hydrogen gas (SH) and ammonia (NH_3). It is also used to detoxify cyanide baths in metal industries. Hypochlorite can be used to prevent algae and shellfish growth in cooling towers. In water treatment, hypochlorite is used to disinfect water. In households, hypochlorite is used frequently for the purification and disinfection of the house.

Sodium hypochlorite is a chemical compound with the formula NaClO.

SOURCES AND ROUTES OF EXPOSURE

Sources of Exposure [3]

- Exposure to sodium hypochlorite can occur at low levels if you use disinfectants like household bleach.
- Exposure may also occur when swimming in pools where it has been added to kill bacteria.
- Drinking water from public drinking water supplies where sodium hypochlorite is added to kill bacteria can also be a source of exposure.
- Workers employed in occupations where sodium hypochlorite is used to bleach paper and textiles may be subject to slightly higher levels of exposure.

Routes of Exposure [4]

The main routes of sodium hypochlorite is via ingestion, contact with the skin and eyes and inhalation of gases.

HEALTH EFFECTS [5]

Acute Exposure

Symptoms of sodium hypochlorite exposure may be immediate, or may be delayed for several hours.

Inhalation

The toxicity of sodium hypochlorite solution by inhalation is predominantly due to the mixing of bleach with acids and the release of highly irritant gases. Metabolic acidosis may occur in rare cases following significant inhalation of sodium hypochlorite. Mixing sodium hypochlorite with acids releases chlorine gas, although in most cases the concentration of chlorine liberated are not sufficient to cause adverse health effects. In rare cases, inhalation of chlorine gas, produced from mixing sodium hypochlorite with acid causes immediate burning of the throat and lungs, eye and nose irritation, chest tightness, coughing, sore throat, wheezing and dyspnoea. In severe cases, bronchospasm, pneumonitis, upper airway oedema, pulmonary oedema or oedema of the glottis may develop. Mixing sodium hypochlorite with ammonia-based solutions results in the formation of monochloramine and dichloramine, both of which are respiratory irritants. In most cases respiratory irritation occurs immediately, followed by a latent period of 5 minutes to 15 hours, after which time breathlessness and bronchospasm may occur. In most cases symptoms are usually resolved in 1 – 4 weeks [5, 8]. However, in some instances pulmonary damage may lead to long-term Reactive Airways Dysfunction Syndrome (RADS), a chemical irritant-induced type of asthma following an acute respiratory exposure to an irritant gas. In addition, Acute Respiratory Distress Syndrome (ARDS), as a result of pneumonitis, has been reported in patients following inhalation of chlorine following the mixing of bleach and other hydrochloric acid.

Ingestion

At low concentrations (up to 10 %), such as those used for household bleach, sodium hypochlorite is a mild to moderate irritant that rarely produces necrosis or significant mucosal injury. Ingestion is not expected to cause severe or permanent damage of the gastrointestinal tract and

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recovery is usually rapid. At higher concentrations (> 10 %) it is corrosive. The critical pH for corrosivity is thought to be 12.5. Ingestion of small volumes (up to 200 ml in adults; 50 ml in children) of sodium hypochlorite solution (< 10 %) usually causes minimal health effects. In some cases it may cause burns to the mouth, throat, oesophagus and stomach, pharyngeal pain and inflammation, gastrointestinal irritation, nausea and vomiting. Dysphagia, stridor, drooling, abdominal pain and dyspnoea may also occur. Severe irritation is uncommon unless contact is prolonged or a large volume is ingested. Ingestion of large amounts (approximately 300 ml in adults; 100 ml in children) of sodium hypochlorite (< 10 %) or more concentrated sodium hypochlorite (> 10 %) may cause corrosive oesophagitis, haematemesis, abdominal and retrosternal pain, diarrhoea and, in some cases, malaena and metabolic acidosis, although symptoms other than vomiting do not strongly correlate with the amount of sodium hypochlorite ingested. In rare cases, the gastrointestinal mucosa may become haemorrhagic, ulcerated and perforated, leading to shock. Hypernatraemia, hyperchloraemia, hypotension and cardiovascular collapse may rarely develop after ingestion of extremely large volumes of sodium hypochlorite (volumes not stated). Aspiration of sodium hypochlorite or aspiration of contaminated vomit may occur. This secondary source of pulmonary exposure may lead to ARDS.

Dermal/Ocular exposure

Sodium hypochlorite itself is corrosive and may irritate the skin or cause burning pain, inflammation and blisters. Skin damage may not be immediately apparent and may continue to develop over time. Ocular exposure to household bleach can cause mild irritation and temporary discomfort if eyes are washed immediately [1]. Irritation becomes more severe and prolonged if eyes are not washed. More concentrated solutions can cause pain, blepharospasm, lacrimation, conjunctivitis, photophobia, necrosis and chemosis of the cornea, clouding of the cornea, iritis, cataract formation and retinitis.

Chronic Effects

Dermal/Ocular exposure

Chronic dermal exposure to sodium hypochlorite solution may cause skin irritation.

Carcinogenicity

No data were available from studies in humans on the carcinogenicity of hypochlorite salts and there was inadequate evidence for the carcinogenicity of hypochlorite salts in experimental animals. Overall, the IARC assigned hypochlorite salts to Group 3, i.e. compounds that are not classifiable as to their carcinogenicity in humans.

Reproductive and developmental toxicity

There are no data indicating that sodium hypochlorite, without severe maternal toxicity, is associated with adverse effects on reproductive function, pregnancy or lactation in humans.

SAFETY [6]

First Aid Measures

- Ingestion: Rinse mouth with water immediately. If swallowed DO NOT induce vomiting. Give a 1-3 glasses of water to drink. If vomiting occurs, place victim head lower then hips to prevent vomiting entering lungs. Seek immediate medical assistance or contact the Poisons Information Centre immediately.
- Eye: Hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes.
- Skin: If spilt on large areas of skin or hair, immediately drench with running water and remove clothing. Continue to wash skin and hair with plenty of water (and soap if material is insoluble) until advised to stop by the Poisons Information Centre or a doctor.
- Inhaled: Remove victim from further exposure. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. Seek medical attention if effects persist.
- Advice to Doctor: Treat symptomatically. Can cause corneal burns. Delayed pulmonary oedema may result.

Exposure Controls & Personal Protection

Engineering Control Measures

- Ensure ventilation is adequate and that air concentrations of components are controlled below quoted Exposure Standards.

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- If inhalation risk exists, use with local exhaust ventilation or while wearing air supplied mask.
- Keep containers closed when not in use.

Personal Protective Equipment

- Wear overalls, face shield, elbow-length impervious gloves, splash apron and rubber boots.
- Always wash hands before smoking, eating, drinking or using the toilet.
- Wash contaminated clothing and other protective equipment before storage or re-use.
- If risk of inhalation exists, wear air supplied respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.

REGULATION

United States [7]

- NIOSH: The National Institute for Occupational Safety and Health recommends an airborne recommended exposure limit (REL) of 0.5ppm for sodium hypochlorite for any 15 min work period.
- AIHA: The American Industrial Hygiene Association recommends a workplace environmental exposure level (WEEL) of 2mg/m^3 for sodium hypochlorite for a 15 min work period.

Australia [6]

No value assigned for this specific material by the National Occupational Health and Safety Commission. However, Exposure Standard(s) for decomposition product(s): Chlorine: Peak Limitation = 3 mg/m^3 (1 ppm).

Peak Limitation - a ceiling concentration which should not be exceeded over a measurement period which should be as short as possible but not exceeding 15 minutes. These Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

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Researchers Find Link Between Artificial Sweeteners and Heart Disease

2022-09-10

A potential direct association between higher artificial sweetener consumption and increased cardiovascular disease risk, including heart attack and stroke has been uncovered by a large study of French adults published on September 7 by The BMJ.

These food additives are consumed daily by millions of people and are present in thousands of foods and drinks. The findings indicate that these artificial sweeteners should not be considered a healthy and safe alternative to sugar, in line with the current position of several health agencies.

Artificial sweeteners are widely used as no or low-calorie alternatives to sugar. They represent a $7.2 billion (£5.9 billion; €7.0 billion) global market and are found in thousands of products worldwide. They are particularly common in ultra-processed foods such as artificially sweetened drinks, some snacks, and low-calorie ready meals.

Several studies have already linked the consumption of artificial sweeteners or artificially sweetened beverages (ASB) to weight gain, high blood pressure, and inflammation. However, findings remain mixed about the role of artificial sweeteners in the cause of various diseases, including cardiovascular disease (CVD). Moreover, several observational studies have used ASB consumption as a proxy to explore CVD risk, but none have measured artificial sweetener intake from the overall diet.

To investigate this further, a team of researchers at the French National Institute for Health and Medical Research (Inserm) and colleagues, drew on data from 103,388 participants (average age 42 years; 80% female) of the web-based NutriNet-Santé study. Launched in France in 2009, this ongoing study investigates relations between nutrition and health.

Dietary intakes and consumption of artificial sweeteners were assessed by repeated 24-hour dietary records. A wide range of potentially influential health, lifestyle, and sociodemographic factors were taken into account.

Artificial sweeteners from all dietary sources (beverages, dairy products, tabletop sweeteners, etc.) and by type (aspartame, sucralose, and acesulfame potassium) were included in the analysis.

A total of 37% of participants consumed artificial sweeteners, with an average intake of 42.46 mg/day. This corresponds to approximately one

These food additives "should not be considered a healthy and safe alternative to sugar," argue researchers.

individual packet of tabletop sweetener or 100 mL (3.4 ounces) of diet soda.

Among participants who consumed artificial sweeteners, mean intakes for lower and higher consumer categories were 7.46 and 77.62 mg/ day, respectively.

Compared with non-consumers, higher consumers tended to be younger, be less physically active, have a higher body mass index (BMI), were more likely to smoke, and to follow a weight loss diet. They also had lower total energy intake, and lower alcohol, carbohydrate, saturated and polyunsaturated fats, fiber, fruit, and vegetable intakes, and higher intakes of sodium, red and processed meat, dairy products, and beverages with no added sugar. However, the investigators took these differences into account in their analyses.

During an average follow-up period of nine years, 1,502 cardiovascular events occurred. They included heart attack, angioplasty (a procedure to widen blocked or narrowed arteries to the heart), angina, transient ischemic attack, and stroke.

The scientists found that total artificial sweetener intake was associated with an increased risk of cardiovascular disease (absolute rate 346 per 100,000 person-years in higher consumers and 314 per 100,000 person-years in non-consumers).

Artificial sweeteners were more particularly associated with cerebrovascular disease risk (absolute rates 195 and 150 per 100,000 person-years in higher and non-consumers, respectively).

Aspartame intake was associated with an increased risk of cerebrovascular events (186 and 151 per 100,000 person-years in higher and non-consumers, respectively), while acesulfame potassium and sucralose were associated with increased coronary heart disease risk (acesulfame potassium: 167 and 164 per 100,000 person-years; sucralose: 271 and 161 per 100,000 person-years in higher and non-consumers, respectively).

Because this is an observational study, it can't establish cause. Additionally, the researchers cannot rule out the possibility that other unknown (confounding) factors might have affected their results.

Nevertheless, this was a large study that evaluated individuals' artificial sweetener intake using precise, high-quality dietary data. Furthermore, the findings are in line with other studies linking exposure to artificial sweeteners with several markers of poor health.

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Therefore, the researchers say their results suggest that there is no benefit from substituting artificial sweeteners for added sugar on CVD outcomes.

Further prospective cohort studies need to confirm these results and experimental studies are required to clarify biological pathways, they add.

In the meantime, they suggest this study provides key insights into the context of artificial sweetener re-evaluation currently being carried out by the European Food Safety Authority, the World Health Organization (WHO), and other health agencies.

Sci Tech Daily, 10 September 2022

https://scitechdaily.com

Researchers generate fusion at 100 million Kelvin for 20 seconds

2022-09-08

A team of researchers affiliated with multiple institutions in South Korea working with two colleagues from Princeton University and one from Columbia University has achieved a new milestone in the development of fusion as an energy source—they generated a reaction that produced temperatures of 100 million Kelvin and lasted for 20 seconds. In their paper published in journal Nature, the group describes their work and where they plan to take it in the next few years.

For the past several years, scientists have been trying to create sustainable fusion reactions inside power plants as a means of generating heat for conversion to electricity. Despite significant progress, the main goal has still not been met. Scientists working on the problem have found it difficult to control fusion reactions—the slightest deviations lead to instabilities that prevent the reaction from continuing. The biggest problem is dealing with the heat that is generated, which is in the millions of degrees. Materials could not hold plasma that hot, of course, so it is levitated with magnets.

Two approaches have been devised: One is called an edge-transport barrier—it shapes the plasma in a way that prevents it from escaping. The other approach is called an internal transport barrier, and it is the kind used by the researchers working at Korea's Superconducting Tokamak Advanced Research Center, the site of the new research. It works by creating an area of high pressure near the center of the plasma to keep it under control.

For the past several years, scientists have been trying to create sustainable fusion reactions inside power plants as a means of generating heat for conversion to electricity.

The researchers note that use of the internal transport barrier results in much denser plasma than the other approach, and that is why they chose to use it. A higher density, they note, makes it easier to generate higher temperatures near the core. It also leads to lower temperatures near the edges of the plasma, which is easier on the equipment used for containment.

In this latest test at the facility, the team was able to generate heat up to 100 million Kelvin and to keep the reaction going for 20 seconds. Other teams have either generated similar temperatures or have kept their reactions going for a similar amount of time, but this is the first time both have been achieved in one reaction.

The researchers next plan to retrofit their facility to make use of what they learned over the past several years of research, replacing some components, such as carbon elements on the chamber walls with new ones made of tungsten, for example.

Phys Org, 8 September 2022

https://phys.org

Where is your seafood really from? We're using 'chemical fingerprinting' to fight seafood fraud and illegal fishing

2022-09-12

Fake foods are invading our supermarkets, as foods we love are substituted or adulterated with lower value or unethical goods.

Food fraud threatens human health but is also bad news for industry and sustainable food production. Seafood is one of most traded food products in the world and reliant on convoluted supply chains that leave the the door wide open for seafood fraud.

Our new study, published in the journal Fish and Fisheries, showcases a new approach for determining the provenance or "origin" of many seafood species.

By identifying provenance, we can detect fraud and empower authorities and businesses to stop it. This makes it more likely that the food you buy is, in fact, the food you truly want to eat.

Illegal fishing and seafood fraud

Natural chemical markers imprinted in the shells and bones of marine animals […] reflect an animal's environment and can identify where they are from.

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Wild-caught seafood is vulnerable to illegal, unreported, and unregulated fishing.

Illegal, unreported, and unregulated fishing can have a devastating impact on the marine environment because:

- it is a major cause of overfishing, constituting an estimated one-fifth of seafood
- it can destroy marine habitats, such coral reefs, through destructive fishing methods such as blast bombing and cyanide fishing
- it can significantly harm wildlife, such as albatross and turtles, which are caught as by-catch.

So how is illegal, unreported, and unregulated fishing connected to seafood fraud?

Seafood fraud allows this kind of fishing to flourish as illegal products are laundered through legitimate supply chains.

A recent study in the United States found when seafood is mislabelled, it is more likely to be substituted for a product from less healthy fisheries with management policies that are less likely to reduce the environmental impacts of fishing.

One review of mislabelled seafood in the US found that out of 180 substituted species, 25 were considered threatened, endangered, or critically endangered by the International Union for Conservation of Nature and Natural Resources (IUCN).

Illegal fishing and seafood fraud also has a human cost. It can:

- adversely affect the livelihoods of law-abiding fishers and seafood businesses
- threaten food security
- facilitate human rights abuses such as forced labour and piracy
- increase risk of exposure to pathogens, drugs, and other banned substances in seafood.

The chemical fingerprints in shells and bones

A vast range of marine animals are harvested for food every year, including fish, molluscs, crustaceans, and echinoderms.

However, traditional food provenance methods are typically designed to identify one species at a time.

That might benefit the species and industry in question, but it is expensive and time consuming. As such, current methods are restricted to a relatively small number of species.

In our study, we described a broader, universal method to identify provenance and detect fraud.

How? We harnessed natural chemical markers imprinted in the shells and bones of marine animals. These markers reflect an animal's environment and can identify where they are from.

We focused on a chemical marker that is similar across many different marine animals. This specific chemical marker, known as "oxygen isotopes", is determined by ocean composition and temperature rather than an animal's biology.

Exploiting this commonality and how it relates to the local environment, we constructed a global ocean map of oxygen isotopes that helps researchers understand where a marine animal may be from (by matching the oxygen isotope value in shells and bones to the oxygen isotope value in the map).

After rigorous testing, we demonstrated this global map (or "isoscape") can be used to correctly identify the origins of a wide range of marine animals living in different latitudes.

For example, we saw up to 90% success in classifying fish, cephalopods, and shellfish between the tropical waters of Southeast Asia and the cooler waters of southern Australia.

What next?

Oxygen isotopes, as a universal marker, worked well on a range of animals collected from different latitudes and across broad geographic areas.

Our next step is to integrate oxygen isotopes with other universal chemical markers to gives clues on longitude and refine our approach.

Working out the provenance of seafood is a large and complex challenge. No single approach is a silver bullet for all species, fisheries or industries.

But our approach represents a step towards a more inclusive, global system for validating seafood provenance and fighting seafood fraud.

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Hopefully, this will mean ensure fewer marine species are left behind and more consumer confidence in the products we buy.

The Conversation, 12 September 2022

https://theconversation.com

A breakthrough discovery in carbon capture conversion for ethylene production

2022-09-09

A team of researchers led by Meenesh Singh at University of Illinois Chicago has discovered a way to convert 100% of carbon dioxide captured from industrial exhaust into ethylene, a key building block for plastic products.

Their findings are published in Cell Reports Physical Science.

While researchers have been exploring the possibility of converting carbon dioxide to ethylene for more than a decade, the UIC team's approach is the first to achieve nearly 100% utilization of carbon dioxide to produce hydrocarbons. Their system uses electrolysis to transform captured carbon dioxide gas into high purity ethylene, with other carbon-based fuels and oxygen as byproducts.

The UIC team's approach is the first to achieve nearly 100% utilization of carbon dioxide to produce hydrocarbons.

The process can convert up to 6 metric tons of carbon dioxide into 1 metric ton of ethylene, recycling almost all carbon dioxide captured. Because the system runs on electricity, the use of renewable energy can make the process carbon negative.

According to Singh, his team's approach surpasses the net-zero carbon goal of other carbon capture and conversion technologies by actually reducing the total carbon dioxide output from industry. "It's a net negative," he said. "For every 1 ton of ethylene produced, you're taking 6 tons of CO2 from point sources that otherwise would be released to the atmosphere."

Previous attempts at converting carbon dioxide into ethylene have relied on reactors that produce ethylene within the source carbon dioxide emission stream. In these cases, as little as 10% of CO2 emissions typically converts to ethylene. The ethylene must later be separated from the carbon dioxide in an energy-intensive process often involving fossil fuels.

In UIC's approach, an electric current is passed through a cell, half of which is filled with captured carbon dioxide, the other half with a water-based

solution. An electrified catalyst draws charged hydrogen atoms from the water molecules into the other half of the unit separated by a membrane, where they combine with charged carbon atoms from the carbon dioxide molecules to form ethylene.

Among manufactured chemicals worldwide, ethylene ranks third for carbon emissions after ammonia and cement. Ethylene is used not only to create plastic products for the packaging, agricultural and automotive industries, but also to produce chemicals used in antifreeze, medical sterilizers and vinyl siding for houses.

Ethylene is usually made in a process called steam cracking that requires enormous amounts of heat. Cracking generates about 1.5 metric tons of carbon emissions per ton of ethylene created. On average, manufacturers produce around 160 million tons of ethylene each year, which results in more than 260 million tons of carbon dioxide emissions worldwide.

In addition to ethylene, the UIC scientists were able to produce other carbon-rich products useful to industry with their electrolysis approach. They also achieved a very high solar energy conversion efficiency, converting 10% of energy from the solar panels directly to carbon product output. This is well above the state-of-the-art standard of 2%. For all the ethylene they produced, the solar energy conversion efficiency was around 4%, approximately the same rate as photosynthesis.

Phys Org, 9 September 2022

https://phys.org

Scientists discover how air pollution triggers lung cancer

2022-09-10

Scientists said Saturday they had identified the mechanism through which air pollution triggers lung cancer in non-smokers, a discovery one expert hailed as "an important step for science—and for society".

The research illustrated the health risk posed by the tiny particles produced by burning fossil fuels, sparking fresh calls for more urgent action to combat climate change.

It could also pave the way for a new field of cancer prevention, according to Charles Swanton of the UK's Francis Crick Institute.

Traditionally it has been thought that exposure to carcinogens, such as those in cigarette smoke or pollution, causes DNA mutations that then become cancer.

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Swanton presented the research, which has not yet been published in a peer-reviewed journal, at the European Society for Medical Oncology's annual conference in Paris.

Air pollution has long been thought to be linked to a higher risk of lung cancer in people who have never smoked.

"But we didn't really know whether pollution was directly causing lung cancer—or how," Swanton told AFP.

Traditionally it has been thought that exposure to carcinogens, such as those in cigarette smoke or pollution, causes DNA mutations that then become cancer.

But there was an "inconvenient truth" with this model, Swanton said: previous research has shown that the DNA mutations can be present without causing cancer—and that most environmental carcinogens do not cause the mutations.

His study proposes a different model.

A future cancer pill?

The research team from the Francis Crick Institute and University College London analyzed the health data of more than 460,000 people in England, South Korea and Taiwan.

They found that exposure to tiny PM2.5 pollution particles—which are less than 2.5 microns across—led to an increased risk of mutations in the EGFR gene.

In laboratory studies on mice, the team showed that the particles caused changes in the EGFR gene as well as in the KRAS gene, both of which have been linked to lung cancer.

Finally, they analyzed nearly 250 samples of human lung tissue never exposed to carcinogens from smoking or heavy pollution.

Even though the lungs were healthy, they found DNA mutations in 18 percent of EGFR genes and 33 percent of KRAS genes.

"They're just sitting there," Swanton said, adding that the mutations seem to increase with age.

"On their own, they probably are insufficient to drive cancer," he said.

But when a cell is exposed to pollution it can trigger a "wound-healing response" that causes inflammation, Swanton said.

And if that cell "harbors a mutation, it will then form a cancer", he added.

"We've provided a biological mechanism behind what was previously an enigma," he said.

In another experiment on mice, the researchers showed that an antibody could block the mediator—called interleukin 1 beta—which sparks the inflammation, stopping cancer from getting started in the first place.

Swanton said he hoped the finding would "provide fruitful grounds for a future of what might be molecular cancer prevention, where we can offer people a pill, perhaps every day, to reduce the risk of cancer".

'Revolutionary'

Suzette Delaloge, who heads the cancer prevention program at France's Gustave Roussy institute, said the research was "quite revolutionary, because we had practically no prior demonstration of this alternative way of cancer forming.

"The study is quite an important step for science—and for society too, I hope," she told AFP.

"This opens a huge door, both for knowledge but also for new ways to prevent" cancer from developing, said Delaloge, who was not involved in the research but discussed it at the conference on Saturday.

"This level of demonstration must force authorities to act on an international scale."

Tony Mok, an oncologist at the Chinese University of Hong Kong, called the research "exciting".

"It means that we can ask whether, in the future, it will be possible to use lung scans to look for pre-cancerous lesions in the lungs and try to reverse them with medicines such as interleukin 1 beta inhibitors," he said.

Swanton called air pollution a "hidden killer", pointing to research estimating it is linked to the deaths of more than eight million people a year—around the same number as tobacco.

Other research has linked PM2.5 to 250,000 deaths annually from lung cancer alone.

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"You and I have a choice about whether we smoke or not, but we do not have a choice about the air we breathe," said Swanton, who is also the chief clinician at Cancer Research UK, which was the main funder of the research.

"Given that probably five times as many people are exposed to unhealthy levels of pollution than tobacco, you can see this is quite a major global problem," he added.

"We can only tackle it if we recognize the really intimate links between climate health and human health."

Medical Xpress, 10 September 2022

https://medicalxpress.com

How a 'Living Drug' Could Treat Autoimmune Disease

2022-09-16

In lupus, A type of autoimmune disease, the body's natural defense system can't tell the difference between its own cells and foreign ones, so it mistakenly attacks its own tissues and organs. The attackers are molecules called autoantibodies, which turn against the body instead of protecting it from invaders, like normal antibodies do. They trigger a cascade of inflammation throughout the body, leading to joint and skin problems, pain, fatigue, and even organ damage.

Now, German researchers report that they have harnessed lupus patients' own cells to treat this disease. The sample size was small, but the results were notable: Five people who received an infusion of supercharged immune cells are now in remission from severe lupus after receiving the experimental treatment. The results appeared on September 15 in the journal Nature Medicine. "This is as close to a cure as I can see," says Hoang Nguyen, senior scientific program manager at the Lupus Research Alliance, who wasn't involved in the study. "They corrected the cells that produce antibodies against the body's own tissues."

The approach is known as CAR-T therapy, and it has been successfully used against some notoriously hard-to-treat cancers. But researchers have been speculating about its potential to treat autoimmune diseases for several years. The therapy involves modifying a patient's T cells, a key component of the immune system, and turning them into assassins to efficiently seek out a specific target in the body. In this case, the target is B cells—the immune cells that make antibodies in healthy people and self-attacking autoantibodies in people with lupus.

In lupus, A type of autoimmune disease, the body's natural defense system can't tell the difference between its own cells and foreign ones, so it mistakenly attacks its own tissues and organs.

Last year, the German team showed that one woman went into remission from severe lupus after CAR-T therapy. The new paper followed four more people who got the therapy.

To make the customized treatment, doctors removed T cells from patients, then genetically engineered them in the lab to recognize a protein called CD19. This protein appears on the surface of autoantibody-producing B cells. Scientists grew more of the modified T cells in the lab until they had enough for a therapeutic dose—around 50 to 100 million, depending on the patient's weight. The modified T cells were then infused back into the patients to seek out and destroy their faulty B cells.

After about 100 days, the patients began to make new B cells—but these ones didn't produce harmful autoantibodies. In fact, the autoantibodies had disappeared altogether. One of the treated individuals has been free of symptoms for 17 months—the longest follow-up period so far. The others have been in remission for five to 12 months. All of the patients have been able to go off the drugs they were taking to manage their illness, including immunosuppressants.

Lupus is a lifelong disease that has no cure. It affects an estimated 1.5 million people in the United States and 5 million people worldwide, many of them young women, according to the Lupus Foundation of America. Most patients are treated with steroids to tame the inflammation. Immunosuppressant drugs are also used, but these make the body more vulnerable to infection and often have unpleasant side effects. New antibody drugs, which aim to protect the body from attacking itself, are able to help some patients but not all.

The new study suggests a possible treatment for lupus patients who don't benefit from currently available drugs. "This impressive study adds to the growing body of evidence that CAR-T therapy may be a therapeutic option for diseases beyond cancer, including autoimmune disorders such as lupus," Jonathan Epstein, executive vice dean and chief scientific officer of the University of Pennsylvania's Perelman School of Medicine, wrote to WIRED via email.

In cancer patients treated with CAR-T therapy, complete remission rates are as high as 68 to 93 percent, but relapse remains common and occurs in 40 to 50 percent of patients. Cancer patients treated with CAR-T therapy can also have a severe inflammatory reaction called cytokine release syndrome. In the lupus study, patients experienced only mild side effects, including fever.

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"The difference between cancer and autoimmunity is that in cancer, there are usually more cells involved," says Georg Schett, vice president of research at the University of Erlangen-Nuremberg in Germany, who was part of the study team. When engineered T cells go after so many tumor cells at once, it can over-activate the immune system and release a potentially life-threatening cytokine storm. "Whereas in autoimmunity, the number of B cells is much lower, and therefore it seems that the safety profile of CAR-T cell therapy and autoimmunity is much better than in cancer," he says.

Schett's team is planning a larger study called a basket trial, in which patients with different types of autoimmune conditions, such as rheumatoid arthritis and scleroderma, will be treated with CAR-T therapy. He says longer follow-up in larger clinical trials will be needed to determine whether the therapy is really a cure.

While these early results are promising, the complexity and cost of CAR-T may limit its use for the foreseeable future. Currently, CAR-T therapies for cancer cost around $400,000 for a one-time infusion. Since they're tailored to each patient, they're complicated to make and require special manufacturing capabilities. Because of these factors, Nguyen says she sees this therapy initially being used as a last resort for patients with severe lupus who don't respond to other drugs. "My first thought when I saw the work was, 'Wow, this is going to be really expensive,'" she says.

Wired, 16 September 2022

https://wired.com

New phases of water detected

2022-09-14

Scientists at the University of Cambridge have discovered that water in a one-molecule layer acts like neither a liquid nor a solid, and that it becomes highly conductive at high pressures.

Much is known about how "bulk water" behaves: it expands when it freezes, and it has a high boiling point. But when water is compressed to the nanoscale, its properties change dramatically.

By developing a new way to predict this unusual behavior with unprecedented accuracy, the researchers have detected several new phases of water at the molecular level.

When water is compressed to the nanoscale, its properties change dramatically.

Water trapped between membranes or in tiny nanoscale cavities is common—it can be found in everything from membranes in our bodies to geological formations. But this nanoconfined water behaves very differently from the water we drink.

Until now, the challenges of experimentally characterizing the phases of water on the nanoscale have prevented a full understanding of its behavior. But in a paper published in the journal Nature, the Cambridge-led team describe how they have used advances in computational approaches to predict the phase diagram of a one-molecule thick layer of water with unprecedented accuracy.

They used a combination of computational approaches to enable the first-principles level investigation of a single layer of water.

The researchers found that water which is confined into a one-molecule thick layer goes through several phases, including a "hexatic" phase and a "superionic" phase. In the hexatic phase, the water acts as neither a solid nor a liquid, but something in between. In the superionic phase, which occurs at higher pressures, the water becomes highly conductive, propelling protons quickly through ice in a way resembling the flow of electrons in a conductor.

Understanding the behavior of water at the nanoscale is critical to many new technologies. The success of medical treatments can be reliant on how water trapped in small cavities in our bodies will react. The development of highly conductive electrolytes for batteries, water desalination, and the frictionless transport of fluids are all reliant on predicting how confined water will behave.

"For all of these areas, understanding the behavior of water is the foundational question," said Dr. Venkat Kapil from Cambridge's Yusuf Hamied Department of Chemistry, the paper's first author. "Our approach allows the study of a single layer of water in a graphene-like channel with unprecedented predictive accuracy."

The researchers found that the one-molecule thick layer of water within the nanochannel showed rich and diverse phase behavior. Their approach predicts several phases which include the hexatic phase—an intermediate between a solid and a liquid—and also a superionic phase, in which the water has a high electrical conductivity.

"The hexatic phase is neither a solid nor a liquid, but an intermediate, which agrees with previous theories about two-dimensional materials,"

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said Kapil. "Our approach also suggests that this phase can be seen experimentally by confining water in a graphene channel.

"The existence of the superionic phase at easily accessible conditions is peculiar, as this phase is generally found in extreme conditions like the core of Uranus and Neptune. One way to visualize this phase is that the oxygen atoms form a solid lattice, and protons flow like a liquid through the lattice, like kids running through a maze."

The researchers say this superionic phase could be important for future electrolyte and battery materials as it shows an electrical conductivity 100 to 1,000 times higher than current battery materials.

The results will not only help with understanding how water works at the nanoscale, but also suggest that "nanoconfinement" could be a new route into finding superionic behavior of other materials.

Phys Org, 14 September 2022

https://phys.org

Air pollution may spur irregular heart rhythms in teens: study

2022-09-14

Breathing in tiny particles of air pollution may trigger irregular heart rhythms in otherwise healthy teenagers and increase their risk of sudden cardiac death, a new study has found.

The study, published in the Journal of the American Heart Association on Wednesday, investigated the impact of inhaling fine particulate matter — also known as PM 2.5 — on heart rhythms of adolescents.

Such particles, which are smaller than 2.5 microns in diameter, are key pollutants in wildfire smoke and in vehicle exhaust and can irritate the lungs and blood vessels of the heart.

"While relatively rare, irregular heart rhythms can lead to sudden cardiac death in otherwise healthy adolescents and young adults," lead author Fan He, an instructor in public health sciences at the Penn State College of Medicine said in a statement.

"Our findings linking air pollution to irregular heart rhythms suggest that particulate matter may contribute to the risk of sudden cardiac death among youth," He added.

Premature ventricular contractions […] also raise the risk of later heat attack, stroke, heart failure or sudden cardiac death.

While the negative impacts of air pollution on adult cardiovascular health have already been determined, this latest study is the first to explore the effects on teenagers in the general population, according to the authors.

The researchers analyzed the impact of inhaling particulate matter pollution on two types of arrhythmias — irregular heart rhythms — characterized by the premature contraction in the heart muscle. This phenomenon, they explained, is also known as a "skipped heartbeat."

In premature atrial contractions, the heartbeat originates from the atria, or the heart's top chambers. While such contractions usually cause no symptoms, their frequent occurrence has been linked to an increased risk of atrial fibrillation — a severe form of arrhythmia in which the atria fail to beat effectively and raise the risk of blood clots and stroke, the scientists noted.

Premature ventricular contractions — when the heartbeat originates from one of the heart's lower chambers, the ventricles — also raise the risk of later heat attack, stroke, heart failure or sudden cardiac death, according to the authors.

When premature contractions cause no symptoms, they are not treated, but when they lead to a frequently skipped heartbeat, doctors may suggest implantable devices or other others, the scientists said.

The researchers analyzed health data for 322 adolescents living in central Pennsylvania in a 2010-2013 follow-up evaluation to a 2002-2006 Penn State Child Cohort study, in which the children were originally ages 6 to 12 years old.

The children were all free of major cardiovascular conditions and were considered at low risk for irregular heart rhythms, according to the study.

As part of the follow-up, the scientists measured exposure to fine particulate matter in the air each teen breathed for 24 hours, while tracking their heart rhythms via a small wearable device.

The average PM 2.5 concentration measured in the study was about 17 micrograms of particulate matter per cubic meter of air — well below the Environmental Protection Agency's standard of 35 micrograms per cubic meter, according to the study.

Nonetheless, the researchers found that 79 percent of the participants had at least one irregular heart rhythm during the 24-hour study period. Of

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that group, 40 percent had only premature atrial contractions, 12 percent had only premature ventricular contractions and 48 percent had both.

The scientists observed a 5-percent increase in the number of premature ventricular contractions within two hours of exposure for each increase of 10 micrograms of PM 2.5 per cubic meter of air.

"It is alarming that we were able to observe such a significant impact of air pollution on cardiac arrhythmias when the air quality remained well within the health-based standards established by the EPA," He said.

Protective measures, such as wearing masks, may be warranted with air pollution concentrations are especially high, according to the scientists, who also called for stronger air quality regulations on a national level.

"It may suggest that adolescents who live in highly polluted areas such as inner cities are at even higher risk," He added.

The Hill, 14 September 2022

https://thehill.com

Using DNA To Convert Carbon Dioxide Into Valuable Products

2022-09-17

Carbon dioxide (CO2) is a significant product of many human activities, including industrial manufacturing. It is also a major contributor to climate change. Therefore, a major goal in the energy sector has been to chemically convert emitted CO2 into fuels or other valuable chemicals. Although CO2 is available in abundance, it has not yet been widely used to generate value-added products. Why not?

One of the main reasons is that CO2 molecules are highly stable. Therefore, they are not very susceptible to being chemically converted to a different form. Scientists have sought materials and device designs that could help spur that conversion, but nothing has worked well enough yet to produce an efficient, cost-effective system.

Ariel Furst is the Raymond (1921) and Helen St. Laurent Career Development Professor of Chemical Engineering at MIT. Two years ago, she decided to try using something different — a material that gets more attention in discussions of biology than chemical engineering. Already, results from work in her lab indicate that her unusual approach is paying off.

Challenges begin with the first step in the CO2 conversion process. CO2 must be chemically converted into carbon monoxide (CO) before being transformed into a useful product.

The stumbling block

Challenges begin with the first step in the CO2 conversion process. CO2 must be chemically converted into carbon monoxide (CO) before being transformed into a useful product. Electrochemistry, a process in which input voltage provides the extra energy needed to make the stable CO2 molecules react, can promote that conversion. The problem is that achieving the CO2-to-CO conversion requires large energy inputs — and even then, CO makes up only a small fraction of the products that are produced.

To explore opportunities for improving this process, Furst and her research group focused on the electrocatalyst, a material that enhances the rate of a chemical reaction without being consumed in the process. The catalyst is key to successful operation. Inside an electrochemical device, the catalyst is often suspended in an aqueous (water-based) solution. When an electric potential (essentially a voltage) is applied to a submerged electrode, dissolved CO2 will — helped by the catalyst — be converted to CO.

But there's one stumbling block: The catalyst and the CO2 must meet on the surface of the electrode for the reaction to occur. In some studies, the catalyst is dispersed in the solution, but that approach requires more catalyst and isn't very efficient, according to Furst. "You have to both wait for the diffusion of CO2 to the catalyst and for the catalyst to reach the electrode before the reaction can occur," she explains. As a result, researchers worldwide have been exploring different methods of "immobilizing" the catalyst on the electrode.

Connecting the catalyst and the electrode

Before Furst could delve into that challenge, she needed to decide which of the two types of CO2 conversion catalysts to work with: the traditional solid-state catalyst or a catalyst made up of small molecules. In examining the literature, she concluded that small-molecule catalysts held the most promise. While their conversion efficiency tends to be lower than that of solid-state versions, molecular catalysts offer one important advantage: They can be tuned to emphasize reactions and products of interest.

Two approaches are commonly used to immobilize small-molecule catalysts on an electrode. One involves linking the catalyst to the electrode by strong covalent bonds — a type of bond in which atoms share electrons; the result is a strong, essentially permanent connection. The other sets up a non-covalent attachment between the catalyst and the electrode; unlike a covalent bond, this connection can easily be broken.

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Neither approach is ideal. In the former case, the catalyst and electrode are firmly attached, ensuring efficient reactions; but when the activity of the catalyst degrades over time (which it will), the electrode can no longer be accessed. In the latter case, a degraded catalyst can be removed; but the exact placement of the small molecules of the catalyst on the electrode can't be controlled, leading to an inconsistent, often decreasing, catalytic efficiency — and simply increasing the amount of catalyst on the electrode surface without concern for where the molecules are placed doesn't solve the problem.

What was needed was a way to position the small-molecule catalyst firmly and accurately on the electrode and then release it when it degrades. For that task, Furst turned to what she and her team regard as a kind of "programmable molecular Velcro": deoxyribonucleic acid, or DNA.

Adding DNA to the mix

Mention DNA to most people, and they think of biological functions in living things. But the members of Furst's lab view DNA as more than just genetic code. "DNA has these really cool physical properties as a biomaterial that people don't often think about," she says. "DNA can be used as a molecular Velcro that can stick things together with very high precision."

Furst knew that DNA sequences had previously been used to immobilize molecules on surfaces for other purposes. So she devised a plan to use DNA to direct the immobilization of catalysts for CO2 conversion.

Her approach depends on a well-understood behavior of DNA called hybridization. The familiar DNA structure is a double helix that forms when two complementary strands connect. When the sequence of bases (the four building blocks of DNA) in the individual strands match up, hydrogen bonds form between complementary bases, firmly linking the strands together.

Using that behavior for catalyst immobilization involves two steps. First, the scientists attach a single strand of DNA to the electrode. Then they attach a complementary strand to the catalyst that is floating in the aqueous solution. When the latter strand gets near the former, the two strands hybridize; they become linked by multiple hydrogen bonds between properly paired bases. As a result, the catalyst is firmly affixed to the electrode by means of two interlocked, self-assembled DNA strands, one connected to the electrode and the other to the catalyst.

Better still, the two strands can be detached from one another. "The connection is stable, but if we heat it up, we can remove the secondary strand that has the catalyst on it," says Furst. "So we can de-hybridize it. That allows us to recycle our electrode surfaces — without having to disassemble the device or do any harsh chemical steps."

Experimental investigation

To explore that idea, Furst and her team — postdocs Gang Fan and Thomas Gill, former graduate student Nathan Corbin PhD '21, and former postdoc Amruta Karbelkar — performed a series of experiments using three small-molecule catalysts based on porphyrins, a group of compounds that are biologically important for processes ranging from enzyme activity to oxygen transport. Two of the catalysts involve a synthetic porphyrin plus a metal center of either cobalt or iron. The third catalyst is hemin, a natural porphyrin compound used to treat porphyria, a set of disorders that can affect the nervous system. "So even the small-molecule catalysts we chose are kind of inspired by nature," comments Furst.

In their experiments, the investigators first needed to modify single strands of DNA and deposit them on one of the electrodes submerged in the solution inside their electrochemical cell. Though this sounds straightforward, it did require some new chemistry. Led by Karbelkar and third-year undergraduate researcher Rachel Ahlmark, the team developed a fast, easy way to attach DNA to electrodes. For this work, the scientists' focus was on attaching DNA, but the "tethering" chemistry they developed can also be used to attach enzymes (protein catalysts), and Furst believes it will be highly useful as a general strategy for modifying carbon electrodes.

Once the single strands of DNA were deposited on the electrode, the researchers synthesized complementary strands and attached to them one of the three catalysts. When the DNA strands with the catalyst were added to the solution in the electrochemical cell, they readily hybridized with the DNA strands on the electrode. After half-an-hour, the researchers applied a voltage to the electrode to chemically convert CO2 dissolved in the solution and used a gas chromatograph to analyze the makeup of the gases produced by the conversion.

The team found that when the DNA-linked catalysts were freely dispersed in the solution, they were highly soluble — even when they included small-molecule catalysts that don't dissolve in water on their own. Indeed, while porphyrin-based catalysts in solution often stick together, once

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the DNA strands were attached, that counterproductive behavior was no longer evident.

The DNA-linked catalysts in solution were also more stable than their unmodified counterparts. They didn't degrade at voltages which caused the unmodified catalysts to degrade. "So just attaching that single strand of DNA to the catalyst in solution makes those catalysts more stable," says Furst. "We don't even have to put them on the electrode surface to see improved stability." When converting CO2 in this way, a stable catalyst will give a steady current over time. Experimental results showed that adding the DNA prevented the catalyst from degrading at voltages of interest for practical devices. Moreover, with all three catalysts in solution, the DNA modification significantly increased the production of CO per minute.

Allowing the DNA-linked catalyst to hybridize with the DNA connected to the electrode brought further improvements, even compared to the same DNA-linked catalyst in solution. For example, as a result of the DNA-directed assembly, the catalyst ended up firmly attached to the electrode, and the catalyst stability was further enhanced. Despite being highly soluble in aqueous solutions, the DNA-linked catalyst molecules remained hybridized at the surface of the electrode, even under harsh experimental conditions.

Immobilizing the DNA-linked catalyst on the electrode also significantly increased the rate of CO production. In a series of experiments, the researchers monitored the CO production rate with each of their catalysts in solution without attached DNA strands — the conventional setup — and then with them immobilized by DNA on the electrode. With all three catalysts, the amount of CO generated per minute was far higher when the DNA-linked catalyst was immobilized on the electrode.

Additionally, immobilizing the DNA-linked catalyst on the electrode greatly increased the "selectivity" in terms of the products. One persistent challenge in using CO2 to generate CO in aqueous solutions is that there is an inevitable competition between the formation of CO and the formation of hydrogen. That tendency was eased by adding DNA to the catalyst in solution — and even more so when the catalyst was immobilized on the electrode using DNA. For both the cobalt-porphyrin catalyst and the hemin-based catalyst, the formation of CO relative to hydrogen was significantly higher with the DNA-linked catalyst on the electrode than in solution. With the iron-porphyrin catalyst they were about the same. "With the iron, it doesn't matter whether it's in solution or on the electrode," Furst explains. "Both of them have selectivity for CO, so that's good, too."

Progress and plans

Furst and her team have now demonstrated that their DNA-based approach combines the advantages of the traditional solid-state catalysts and the newer small-molecule ones. In their experiments, they achieved the highly efficient chemical conversion of CO2 to CO and also were able to control the mix of products formed. And they believe that their technique should prove scalable: DNA is inexpensive and widely available, and the amount of catalyst required is several orders of magnitude lower when it's immobilized using DNA.

Based on her work thus far, Furst hypothesizes that the structure and spacing of the small molecules on the electrode may directly impact both catalytic efficiency and product selectivity. Using DNA to control the precise positioning of her small-molecule catalysts, she plans to evaluate those impacts and then extrapolate design parameters that can be applied to other classes of energy-conversion catalysts. Ultimately, she hopes to develop a predictive algorithm that researchers can use as they design electrocatalytic systems for a wide variety of applications.

Sci Tech Daily, 17 September 2022

https://scitechdaily.com

Alzheimer's Disease Risk 50–80% Higher in Older Adults Who Caught COVID-19

2022-09-15

Older people who had a COVID-19 infection show a considerably higher risk—as much as 50% to 80% higher than a control group—of developing Alzheimer's disease within a year. This is according to a new research study of more than 6 million patients aged 65 and older.

Researchers report that people 65 and older who contracted COVID-19 were substantially more likely to develop Alzheimer's disease in the year following their COVID diagnosis. Furthermore, the highest risk was observed in women at least 85 years old. The study was published on September 13, 2022, in the Journal of Alzheimer's Disease,

According to the findings, the risk for developing Alzheimer's disease in older people nearly doubled (0.35% to 0.68%) over a one-year period following COVID infection. It is unclear whether COVID-19 triggers new development of Alzheimer's disease or accelerates its emergence, the researchers said.

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According to a large, new study, older people who were infected with COVID-19 show a substantially higher risk of developing Alzheimer's disease within a year.

"The factors that play into the development of Alzheimer's disease have been poorly understood, but two pieces considered important are prior infections, especially viral infections, and inflammation," said Pamela Davis, the study's coauthor. She is a Distinguished University Professor and The Arline H. and Curtis F. Garvin Research Professor at the Case Western Reserve School of Medicine.

"Since infection with SARS-CoV2 has been associated with central nervous system abnormalities including inflammation, we wanted to test whether, even in the short term, COVID could lead to increased diagnoses," she said.

For the study, the research team analyzed the anonymous electronic health records of 6.2 million adults 65 and older in the United States with no prior diagnosis of Alzheimer's disease who received medical treatment between February 2020 and May 2021.

They then divided this population into two groups. One was composed of people who contracted COVID-19 during that period, and the other group contained people who had no documented cases of COVID-19. More than 400,000 people were enrolled in the COVID study group, while 5.8 million were in the non-infected group.

"If this increase in new diagnoses of Alzheimer's disease is sustained, the wave of patients with a disease currently without a cure will be substantial, and could further strain our long-term care resources," Davis said. "Alzheimer's disease is a serious and challenging disease, and we thought we had turned some of the tide on it by reducing general risk factors such as hypertension, heart disease, obesity and a sedentary lifestyle. Now, so many people in the U.S. have had COVID and the long-term consequences of COVID are still emerging. It is important to continue to monitor the impact of this disease on future disability."

Rong Xu, the study's corresponding author is professor of Biomedical Informatics at the School of Medicine and director of the Center for AI in Drug Discovery. She said the research team plans to continue studying the effects of COVID-19 on Alzheimer's disease and other neurodegenerative disorders—especially which subpopulations may be more vulnerable—and the potential to repurpose FDA-approved drugs to treat COVID's long-term effects.

Previous COVID-related research led by CWRU have found that people with dementia are twice as likely to contract COVID; those with substance abuse disorder orders are more likely to contract COVID; and that 5% of

people who took Paxlovid for treatment of COVID symptoms experienced rebound infections within a month.

Sci Tech Daily, 15 September 2022

https://scitechdaily.com

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Gut microbes may lead to therapies for mental illness, study reports

2022-09-09

The role of the microbiome in intestinal and systemic health has garnered close attention among researchers for many years. Now evidence is mounting that this collection of microorganisms in the human gut can also impact a person's neurological and emotional health, according to a recent perspective article in Science by a UT Southwestern researcher.

Neuroscientist Jane Foster, Ph.D., Professor of Psychiatry at UT Southwestern and a leading expert on the microbiome, outlines how scientists are unraveling the relationship of the microbiome to the brain, including connections to diseases such as depression and amyotrophic lateral sclerosis (ALS). Dr. Foster, who was the first to link microbes in the guts of mice to anxiety, said animal studies have revealed certain microbes and related metabolites that increase anxiety-like behavior and brain function. Translating these findings to clinical populations could lead to novel therapies to improve symptoms and clinical outcomes.

Dr. Foster joined UT Southwestern and its Center for Depression Research and Clinical Care (CDRC) in May to lead the effort to connect the dots between a person's 39 trillion gut microbes and their propensity for brain disease. She previously served as Professor at McMaster University in Ontario and co-molecular lead of The Canadian Biomarker Integration Network in Depression (CAN-BIND).

"People who are at risk for depression or diagnosed with depression are heterogeneous. So we want to use biology to understand the biomarkers that can help define the different clusters of people," Dr. Foster said.

She said UT Southwestern's approach, which is built on the premise that clinical care and research go hand-in-hand, attracted her to join the center.

"That holistic approach is necessary if we are going to find better answers for people suffering with mental illness," Dr. Foster said.

The CDRC conducts research in unipolar and bipolar depression to better understand the causes of depression, identify new treatments, and improve existing ones.

"I am very pleased that we were able to recruit Dr. Foster to join our center, given our continuing goal to investigate the biosignature of mental health through a multipronged approach," said Madhukar H. Trivedi, M.D., Professor of Psychiatry and Director of the CDRC.

Evidence is mounting that this collection of microorganisms in the human gut can also impact a person's neurological and emotional health.

Drs. Foster and Trivedi previously collaborated to look for immune markers in blood samples obtained through CAN-BIND to see how inflammation might influence depression, and in stool samples collected from participants in the longitudinal Texas Resilience Against Depression study. If the sample from a patient with depression yields certain microbes that are associated with treatment success from certain antidepressants or therapies, this may drive personalized medicine for this patient.

"Currently we have a host of treatment choices, yet decisions are predominantly based on behavior and self-report, and imaging and EEGs in some cases," Dr. Foster said. "Antidepressants typically work for just around 40% of people. Other choices include cognitive behavioral therapy, deep brain stimulation, or even exercise and diet. By expanding on the individual patient's profile, can we now improve the number of people that respond to a particular treatment?"

Dr. Trivedi holds the Betty Jo Hay Distinguished Chair in Mental Health, and the Julie K. Hersh Chair for Depression Research and Clinical Care.

Medical Xpress, 9 September 2022

https://medicalxpress.com

Some of the Most Common Medications Can Cause Permanent Side Effects in Children

2022-09-15

A recent study demonstrates that early exposure to antibiotics destroys beneficial bacteria in the digestive system and can cause asthma and allergies.

The research, which was published in the journal Mucosal Immunology, has offered the strongest evidence to date that the long-recognized link between early antibiotic exposure and the later onset of asthma and allergies is causative.

"The practical implication is simple: Avoid antibiotic use in young children whenever you can because it may elevate the risk of significant, long-term problems with allergy and/or asthma," said senior author Martin Blaser, director of the Center for Advanced Biotechnology and Medicine at Rutgers.

The study's authors, from Rutgers University, New York University, and the University of Zurich, stated that antibiotics, "among the most used medications in children, affect gut microbiome communities and

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metabolic functions. These changes in microbiota structure can impact host immunity."

Five-day-old mice were given water, azithromycin, or amoxicillin in the first stage of the experiment. After the mice reached adulthood, scientists exposed them to a common allergen produced by house dust mites. Mice that had taken either antibiotic, particularly azithromycin, had heightened immunological responses — i.e., allergies.

The second and third stages of the experiment tested the hypothesis that certain healthy gut bacteria that are critical for proper immune system development are killed by early exposure to antibiotics (but not later exposure), which results in allergies and asthma.

Timothy Borbet, the lead author, initially transferred fecal samples rich in bacteria from the first group of mice to a second group of adult mice with no previous exposure to any bacteria or germs. Some received samples from mice given azithromycin or amoxicillin in infancy. Others received normal samples from mice that had received water.

Mice that received antibiotic-altered samples were no more likely than other mice to develop immune responses to house dust mites, just as people who receive antibiotics in adulthood are no more likely to develop asthma or allergies than those who don't.

Things were different, however, for the next generation. Offspring of mice that received antibiotic-altered samples reacted more to house dust mites than those whose parents received samples unaltered by antibiotics, just as mice that originally received antibiotics as babies reacted more to the allergen than those that received water.

"This was a carefully controlled experiment," said Blaser. "The only variable in the first part was antibiotic exposure. The only variable in the second two parts was whether the mixture of gut bacteria had been affected by antibiotics. Everything else about the mice was identical.

Blaser added that "these experiments provide strong evidence that antibiotics cause unwanted immune responses to develop via their effect on gut bacteria, but only if gut bacteria are altered in early childhood."

Sci Tech Daily, 15 September 2022

https://scitechdaily.com

"These experiments provide strong evidence that antibiotics cause unwanted immune responses to develop via their effect on gut bacteria, but only if gut bacteria are altered in early childhood."

Strictest test yet of general relativity confirms feathers and bowling balls really do fall at the same rate

2022-09-14

A pillar of Albert Einstein's theory of general relativity—and a staple of middle school science class demonstrations—has passed its most stringent test yet. A new space-based experiment aboard the European satellite MICROSCOPE has confirmed with unprecedented precision that masses made of different materials fall at exactly the same rate under gravity.

It's "really good" to have Einstein's theory confirmed with such high precision, says Eugene Lim, a theoretical physicist at King's College London who wasn't involved with the work. The results aren't surprising, he adds, but these kinds of experiments could help physicists narrow down future gravitational theories that fit with quantum theory and better predict how black holes behave.

MICROSCOPE launched in 2016 to test Einstein's Weak Equivalence Principle. Simply put, the principle states that gravity is universal. No matter what an object is made of—be it lead or sawdust—it will accelerate in the same way under a gravitational field. In one famous—possibly apocryphal—demonstration, the famed astronomer and physicist Galileo Galilei is said to have dropped two spheres of differing masses from the top of the Leaning Tower of Pisa and watched them land at the same time. (In reality, many historians agree this was likely just one of Galileo's thought experiments.) Physicists have carried on the tradition for centuries, poking and prodding at this principle under a variety of experimental conditions.

Space is just the latest frontier for such tests. A chamber inside MICROSCOPE contained a series of electrically charged cylinders made of platinum and titanium alloy. These test masses were kept in place by static electricity as they orbited around Earth. Because orbiting is equivalent to falling, at least as far as gravity is concerned, the masses were essentially kept in a state of constant free fall. An extremely sensitive electrical sensor measured the amount of voltage required to keep each object stationary.

If one of the objects were to accelerate faster than the other, it would need a higher voltage to keep it place. But that isn't what happened. As expected, the rates of acceleration of the two objects remained equal throughout the experiment, researchers report today in Physical Review Letters.

A satellite mission backs up—with meticulous precision—major gravitational principle

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The results may not rewrite any textbooks, says mission co-leader Manuel Rodrigues, a research engineer at ONERA, the French Aerospace Lab. But they're more precise than those achieved by previous experiments, he says, including a 2017 study that also used MICROSCOPE. "We were able to improve the accuracy of the measurements by a factor of 10."

Lim adds that the new study's precision lends confidence to past work on various aspects of the principle. "We now know that the results we've gotten from other experiments are robust."

Such work could help physicists shore up holes in Einstein's theory of general relativity, which many physicists believe is incomplete, Lim says. It's difficult to reconcile general relativity with quantum mechanics, for example.

Rodrigues adds that scientists do not fully understand how to square general relativity with phenomena such as black holes, where gravitational forces are so strong they prevent light from escaping.

Experiments like MICROSCOPE could help scientists develop new theories to solve these dilemmas, Lim says.

Science, 14 September 2022

https://science.org

What are uterus transplants? Who donates their uterus? And what are the risks?

2022-09-16

The opportunity to conceive, carry and give birth to a biologically related child is a deep desire for many women and their partners. Since the introduction of IVF in 1978, many people in countries such as Australia have accessed support and resources to help realise their reproductive goals.

For some women, the lack of a functioning uterus has kept that opportunity out of reach. This includes those with a congenital condition such as Mayer-Rokitansky-Küster-Hauser syndrome, and those who had a hysterectomy for medical reasons.

For these women, the only options for parenthood have been surrogacy or adoption. Access to both is often difficult.

Most uterus transplants so far have used altruistic living donors, typically a mother donating to her daughter or an aunt to her niece.

Uterus transplants are changing that. From next year, uterus transplants are being trialled in Australia. However, there are risks involved and ethical concerns which must be addressed before it can become mainstream clinical treatment.

How does the process work?

Uterus transplantation is a set of medical procedures in which a donated uterus is surgically removed from a suitable donor and transplanted into an eligible recipient.

Hormones are used to stimulate menstruation in the recipient, and once the uterus is functioning normally, an IVF-created embryo is transferred into the woman's uterus.

Following successful implantation and healthy development, the baby is delivered via caesarean section. This is because a uterus transplant pregnancy is regarded as high risk, and the woman may not be able to feel contractions. Women with the congenital absence of a uterus will not be able to deliver vaginally.

As with all transplants, the uterus recipient is prescribed immunosuppression medication to prevent rejection of the donor organ. These drugs are administered at levels deemed safe for the developing foetus. Close monitoring continues throughout the pregnancy to ensure the safety of both woman and foetus.

Immunosuppression continues until the delivery of up to two healthy babies or five years after the transplant, whichever is first.

The uterus is then surgically removed via hysterectomy, enabling immunosuppression – which carries risks and side-effects – to be ceased. Risks from immunosuppression include infection, reduced blood cell count, heart disease and suppression of bone marrow growth. And these risks increase with time.

Uterus transplantation is an "ephemeral" transplant: a non-life-saving temporary transplant, aimed solely at enabling reproduction. These features make it medically and ethically distinct from other transplants.

When did uterus transplants start?

Scientists started developing uterus transplantation in animals in the 1970s. The first attempts in humans occurred in 2000 (Saudi Arabia) and 2011 (Turkey), both of which failed.

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After 14 years of research, Professor Mats Brannstrom and his team at Sweden's Sahlgrenska University Hospital started the world's first human trials in 2013. In 2014, the first healthy baby was born.

With more than 25 countries now performing or planning uterus transplants, it is estimated that at least 80 procedures have been performed, resulting in more than 40 healthy live births. While not all transplants are successful, the live birth rate from a uterus that is functioning successfully after transplantation is estimated at over 80%.

In Australia, two trials have been approved and plan to start within the next 12-18 months.

Who donates?

Most uterus transplants so far have used altruistic living donors, typically a mother donating to her daughter or an aunt to her niece.

But cases using uteruses from deceased donors have also been successful, with at least four healthy live births reported.

Uteruses from deceased donors are mostly provided through standard family consent methods for medical research. But in future they could be provided through organ donor registration processes modified to include the uterus.

Currently, only pre-menopausal women can be uterus donors, and living donors need to have had a successful pregnancy to be eligible to donate. But this may not need to be a requirement for deceased donors, potentially enabling younger donors and increasing the availability of uteruses for transplantation.

Of the two approved Australian trials, only one (led by Royal Hospital for Women, for which I provide independent ethical advice) will conduct both living and deceased donor uterus transplantation. The other (through Royal Prince Alfred hospital) will trial only living donor transplantation.

Participation in these uterus transplant trials will remain limited while uterus transplantation is still in the research phase, and will depend on the availability of funding.

What are the risks of living donation?

For recipients, the main surgical risks are organ rejection, infection, and blood clots or thrombosis, as well as risks arising from the surgery duration

(average 5 hours) such as blood clots (including in the lung) and from immunosuppression.

While challenging, these risks have been minimised through close monitoring and early intervention using blood thinners and encouraging recipients to move around soon after surgery.

For living donors, physical risks arise from surgery duration (6-11 hours) and operative and postoperative complications, the most common being urinary tract injury and infection.

There are also ethical and psychological risks. These include the possibility of a potential donor feeling pressured to donate to a family member, and experiencing guilt and failure if the transplant is not successful or results in adverse outcomes.

These risks may be reduced with appropriate counselling and support. But as with all altruistic organ donation, they cannot be entirely eliminated.

What about deceased donation?

Deceased donor transplantation also carries risks but involves less surgical time than living donor transplantation (typically 1-2 hours) and therefore less demand on medical resources and personnel.

Deceased donor transplantation may be less ethically fraught. There is no prospect of pressure, guilt or surgical risk to the deceased donor, who must have been declared brain dead and be suitable for multi-organ donation. Their organs may only be procured with proper consent, following the usual protocols and procedures.

In Australia, as elsewhere, organ donors are in short supply. But deceased donors might be found via existing donation registries and consent processes, such as those managed by DonateLife and NSW Organ and Tissue Donation Services.

Why investigate both types of donation?

It's important to be able to compare the outcomes of living and deceased donation in similar recipients and contexts. This will inform future guidelines and policies around uterus donation, and determine whether it can become mainstream clinical practice.

Emerging evidence suggests deceased donation may yield better results for recipients. Using deceased donor organs allows longer veins and

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arteries to be retrieved, enabling better blood flow for the uterus and potentially greater success in transplants and pregnancies.

So although there are currently fewer cases of deceased donors, there are sound medical and ethical reasons for Australian uterus transplant research with both deceased and living donors.

The Conversation, 16 September 2022

https://theconversation.com

Engineering an Enzyme To Treat Anthrax Without Antibiotics

2022-09-14

Anthrax-causing spores were mailed to news organizations and members of Congress during the "Amerithrax" attacks of 2001, sickening at least 22 people and killing five. Researchers are gearing up to combat the bacteria's antibiotic-resistant variants, which are a rising source of concern. Now, a team has made progress toward the creation of a therapy that may treat the infection in mice without the use of antibiotics, as reported today (September 14, 2022) in the journal ACS Infectious Diseases.

Bacillus anthracis is a type of gram-positive, rod-shaped bacteria that can lead to anthrax infection through exposure to its spores, either by ingestion, inhalation, or a cut in the skin. Anthrax infection can lead to difficulty breathing, skin ulcers, or even death. Although antibiotics against anthrax exist, resistance to these drugs can occur over time.

One type of B. anthracis, called the Ames strain, is particularly virulent because the bacteria can wrap itself in a protective capsule of poly-D-glutamic acid. This acts like a cloak of invisibility, which helps the bacteria evade the human immune system. A B. anthracis enzyme called CapD anchors the capsule material to the bacteria. However, previous studies have reported that the enzyme can be engineered to degrade the capsule instead, making the bacteria susceptible to the immune system.

Studies have also demonstrated that providing mice with the engineered CapD can help treat an Ames-strain anthrax infection without the use of antibiotics. Additionally, Patricia Legler and colleagues have demonstrated that adding polyethylene glycol (PEG) to this version of CapD can help the enzyme last longer, increasing mouse survival. In this new study, the research team wanted to optimize the treatment even further.

Bacillus anthracis is a type of gram-positive, rod-shaped bacteria that can lead to anthrax infection through exposure to its spores, either by ingestion, inhalation, or a cut in the skin

To improve the re-engineered enzyme's lifetime in the body and deliver a bigger punch, the scientists added PEG and fused the CapD protein with part of a mouse antibody. This resulted in two CapD enzymes bound together, which would essentially double its capsule-binding power. The research team created several versions of the enzyme and subjected them to many rounds of optimization, deleting and inserting different segments until they achieved a sequence that both held its 3D shape and performed as expected in a range of pH values.

When tested in a mouse model, this construct lasted longer than the previous version without the fused antibody, though it had reduced activity. The scientists say that more research is needed to produce the ideal construct, but the results are an important step toward a better treatment against antibiotic-resistant B. anthracis strains.

Sci Tech Daily, 14 September 2022
https://scitechdaily.com

How can the global chemical industry get to net zero?

2022-09-14

Industrial chemicals, like ammonia, methanol and ethylene, are crucial feedstocks for over a dozen different sectors – from healthcare, agriculture and construction, to packaging, cars, and textiles.

But these chemicals have a carbon footprint. At the moment, the global chemical industry makes up around 4% of global greenhouse gas emissions.

But, according to a new report from the University of Tokyo and consultancy company Systemiq, there are ways for the industry to hit net zero emissions well before 2050 – and even the possibility of becoming carbon negative.

"The chemical industry underpins every modern economy, but it must change profoundly across its entire value chain to meet the objectives of the Paris Agreement," says Guido Schmidt-Traub, managing partner of Systemiq.

"Importantly, these changes are eminently feasible using proven technologies outlined in this report. The recommendations for policymakers, the industry and the investment community are practical and actionable."

A new report outlines how to decarbonise the modern world's most crucial feedstocks.

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The report outlines three different scenarios to 2050: a business-as-usual scenario; the "most economic" way to hit net zero emissions by 2050; and the fastest way.

"These scenarios are not forecasts but use the best available data to describe what needs to happen to bring about net zero through different approaches," reads the report.

The lowest-cost net-zero scenario results in 9 more gigatonnes of carbon dioxide (or equivalent) in the atmosphere by 2050. While half a trillion dollars more expensive, the fastest-abatement scenario is the only scenario modelled to be carbon negative by 2050. (For context, the world currently emits around 35 gigatonnes of carbon dioxide, or equivalent greenhouse gases, each year.)

The business-as-usual scenario is consistent with 4°C of global warming.

There is an enormous range of work that needs to be done to achieve a net-zero switch, according to the report: circular economy approaches need to be aggressively adopted, the industry needs to decouple from fossil fuels and switch to renewable feedstocks, and renewable energy and carbon capture and storage need to be widely deployed.

The transition to net zero would create roughly 29 million jobs around the world.

The report highlights ammonia and methanol particularly, both of which will be in high demand in a net-zero world: ammonia as a method of storing green hydrogen fuel, and methanol as a way to make plastics without fossil fuels.

Methanol can be made with captured carbon dioxide, opening it up as a potential carbon sink industry.

"To avoid the collapse of the complex and interdependent Earth systems on which humanity, including our economic prosperity depends, we need to transform our social and economic systems and our lifestyles," says Professor Naoko Ishii, executive vice president at the University of Tokyo and director of the university's Center for Global Commons.

"The chemical industry has an outsized role to play, with its products used across many sectors and is ubiquitous in modern life.

"The opportunity is clear: to bring the system back within the planetary boundaries, including net zero GHG (greenhouse gases) and become a

contributor to the global commons (the stable and resilient Earth system that sustains our lives)."

Cosmos, 14 September 2022

https://cosmosmagazine.com

Is polio back? Here's what you need to know

2022-09-14

Polio, considered eradicated in nearly every country on the planet, has returned in the US, UK and Israel.

Currently, the last wild strain of polio can only be found in Pakistan and Afghanistan. In the rest of the world, it's kept at bay by strong immunisation programs where three injections of the polio vaccine are considered to bestow the recipient 99% effective disease prevention.

Such programs have run across the world for over three decades.

That's why the reports of the disease in developed nations with strong immunisation history are so surprising. Cases have been reported in New York State and the virus has been detected in London and Jerusalem wastewater tests.

Polio is usually transmitted person-to-person by faecal-oral transmission, highlighting the importance of basic public hygiene, including even the simplest act of hand washing.

Initially, the virus may infect the throat and increase the risk of respiratory transmission, but it then enters the digestive system where it replicates in the gut and is shed in faeces for at least six weeks.

Nine in 10 people infected with poliovirus will be asymptomatic and recover. Some might have nothing more than a fever and sore throat. These symptoms may be indistinguishable from those of other diseases.

It's when the virus gets into the spinal cord that the most severe symptom – paralysis – can occur. Around one percent of infected people will experience this severe symptom.

But polio management isn't a case of prevention being better than cure.

There is no cure.

How has polio returned in the USA

New York State, London and Jerusalem are detecting poliovirus. How can an eradicated disease suddenly come back?

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Having no cure available for polio is why health authorities around the world use immunisation programs to prevent the disease spreading.

Largely, these have been successful: wild poliovirus type 1 remains only in Pakistan and Afghanistan. Types 2 and 3 have been globally eradicated.

In the United States, over 92% of children under two years of age are immunised against polio. Among the standard suite of seven childhood vaccines recommended for various infectious diseases, polio has the highest rate of uptake among US children.

That figure is similar in other nations – around 93% in the UK and Israel are immunised against the virus.

And yet cases and wastewater detection in these countries indicates it is spreading again.

The response has been swift: New York's governor this week declared a state of emergency to address the emergence of the disease, mobilising more health services to administer the vaccine to those who need it. The UK has implemented a campaign to get vaccine into the arms of unprotected children.

It would be easy to assume that wild polio has hitched a ride to these places from a nation where it remains active, and it would be possible – travelling to or from Pakistan or Afghanistan does carry the risk of transmitting Type 1 polio.

But authorities aren't finding the wild virus in the US, UK or Israel. Rather, a 'vaccine-derived' form of polio has emerged.

While that might seem surprising, vaccine-derived poliovirus (VDPV) is somewhat common, and it's due to the survival tactics employed by all viruses.

How to make a vaccine-derived poliovirus

A live, attenuated (diminished) form of the virus is used in oral polio vaccines (OPVs). These are administered through the mouth and widely used in nations which need to swiftly stifle an outbreak. Once eradication has been achieved, authorities generally implement injected polio vaccine programs (IPVs), which use an inactive version of the virus.

Because OPVs are administered as droplets in the mouth, they eventually mimic a natural polio infection in the gut, which provides mucosal

immunity. IPVs trigger a less strong – but still very effective – antibody response.

It's the presence of live virus in OPVs that carries some risk of eventual viral escape.

Even though the attenuated virus in OPVs are weaker, they're still capable of doing the one thing viruses are renowned for: Mutating.

As Royal Melbourne Hospital's Associate Professor Bruce Thorley, director of the World Health Organization's Polio Regional Reference Laboratory at the Doherty Institute told Cosmos, this is why the disease has been discovered among unvaccinated people in the US.

"The normal part of the replication cycle of the polio virus, whether it's a wild polio virus or vaccine strain, can have mutations during the replication cycle, where the sequence within the viral genome may change as it is growing in the gut," Thorley says.

"What can occur is in areas of lower vaccine coverage, you can get the vaccine virus being shed in the stool [of vaccinated people].

"And then if, through person-to-person contact, it infects someone who's not immunised, that virus will continue to grow and may accumulate another mutation.

"The vaccine strain can incorporate a number of mutations that then lose its weakened form, and then it can actually cause polio.

"That is what has been described in New York."

This is partly why successful immunisation programs rely on hitting a base level of vaccine coverage to prevent serious infectious diseases spreading.

On face value, coverage of over 90% vaccination among a national population should be more than enough to prevent the spread.

In Australia, estimates published in Communicable Diseases Intelligence (CDI) suggest around 82 percent of people are immunised against type 1 wild poliovirus. These are "sufficient to prevent outbreaks of this type."

Other countries have similar levels of immunisation.

But reports suggest that polio has remerged in New York State by spreading among vaccine-resistant communities, where some immunisation rates in these areas could be as low as 37%.

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This is where the concept of 'herd immunity' takes a hit.

Strong national-level immunisation might mask lower rates in communities

"We estimate polio vaccination coverage to be about 80 to 85% of the Australian population," says Dr Daryl Cheng, who is the medical lead at the Melbourne Vaccine Education Centre

While polio has not re-emerged in Australia, another infectious disease – diphtheria – has.

How can this happen, when diphtheria vaccination rates among children have been over 90% nationally since 2000?

Some age demographics – in this case, people born before 2000 – might be 'under-vaccinated'.

Similarly, some geographic areas may have lower rates of vaccination masked by the high national average. This is what parts of New York state are seeing with polio's return – while a nation's population may have a strong level of overall immunisation, herd immunity may not necessarily exist in smaller communities.

Earlier his year, two diphtheria cases were reported in children for the first time since 1992 in northern New South Wales. This region has that state's lowest level of fully immunised people under five years.

Diphtheria immunisation rates in this region are some of the lowest in Australia – around 85% in some pockets.

"The diphtheria rates – or the childhood vaccination rates in general – were below the herd immunity threshold, putting them at risk," says Cheng.

"If you looked at that population, let's hypothetically say their coverage was 40%, or 30%, or 60% below the heavy immunity rates – or the calculated herd immunity rate – it would place that population at risk of a specific vaccine preventable disease."

While no Australian jurisdiction reports childhood vaccination rates as low as the 37 percent levels touted in some parts of New York State, fewer than 4 in 5 children in some areas and age brackets are fully vaccinated.

Cheng says the high level of public discussion around COVID-19 vaccines over the past two years may have resulted in broader reluctance for

parents to immunise their children, and that is something health authorities and educators are trying to repair.

"Just because the COVID vaccines are new doesn't mean the measles vaccine is new, the measles vaccine has been around for many years, the polio vaccine has been around for years and years," Cheng says.

"People who previously did not question, or would get their kids vaccinated on time, because of the impacts of the discussions around COVID vaccines, have thought twice about bringing their kids to get vaccinated."

Cosmos, 14 September 2022

https://cosmosmagazine.com

Metal powder: Zero-carbon fuel for the future?

2022-09-16

Gaining sustainable energy from wind, solar and water is commonly known and applied. However, renewable sources depend on environmental conditions: in peak times of wind and sun, excess energy is produced that is needed in times of less wind and sunshine. But how to store and transport this excess energy efficiently?

So far, no reliable, safe and cheap way has been found to store a high amount of energy in a small volume container. Now, scientists from the Max-Planck-Institut für Eisenforschung (MPIE) and the Eindhoven University of Technology analyzed how metals, particularly iron, can be used for energy storage and which parameters determine the efficiency of the storage and reuse. They published their recent findings in the journal Acta Materialia.

Creating a circular reduction and combustion process

"Storing energy in metals and burning them to free the energy whenever needed is a method already applied in aerospace technology. Our aim was to understand what exactly happens at the micro- and nanoscale during the reduction and combustion of iron and how the microstructure evolution influences the efficiency of the process. Additionally, we wanted to find how to make this process circular without losses in energy or material," explains Dr. Laurine Choisez, who recently finished her postdoctoral research at the MPIE and who is first author of the publication.

Energy is stored while reducing iron oxide to iron. Energy is freed while combusting iron back to iron oxide. Optimizing this process could lead to a fully circular, thus sustainable storage of energy.

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When iron ores are reduced to iron, a lot of energy is naturally stored in the reduced iron. The idea is to get this energy out of the iron whenever needed by oxidizing the iron back to iron oxide. In times of excess energy from wind, sun or water, this iron ore could be again reduced to iron and the energy stored.

The scientists speak of combustion when describing the "burning," meaning oxidation, of the iron back to iron ore. Choisez and her colleagues at MPIE focused on the characterization of the iron powders after reduction and combustion using advanced microscopy and simulation methods to analyze the powder purity, morphology, porosity and the thermodynamics of the combustion process.

The obtained microstructure of the combusted iron powders is decisive for the efficiency of the following reduction process, and to determine whether the process of reduction and combustion is fully circular, meaning that no additional energy or material has to be added.

Energy is stored while reducing iron oxide to iron. Energy is freed while combusting iron back to iron oxide. Optimizing this process could lead to a fully circular, thus sustainable storage of energy. Credit: Laurine Choisez, Max-Planck-Institut für Eisenforschung GmbH

Upscaling for industrial use

The scientists present two combustion pathways, one supported by a propane pilot flame and one self-sustained in which the only fuel used is the iron powder, and show how the combustion pathway influences the microstructure of the combusted iron.

"We are currently upscaling the reduction and combustion steps to an industrial relevant level determining the exact parameters like temperature and particle size, which are needed," explains Niek E. van Rooij, doctoral researcher in the Combustion Technology group of the Eindhoven University of Technology and co-author of the publication.

The recent study showed that using metals to store energy is feasible. Future studies will now analyze how to increase the circularity of the process, as the size of some combusted particles is decreased compared to their original size due to partial iron evaporation, micro-explosions and/or fracture of some iron oxide particles.

Tech Xplore, 16 September 2022

https://techxplore.com

Chaos Researchers Can Now Predict Perilous Points of No Return

2022-09-15

redicting complex systems like the weather is famously difficult. But at least the weather's governing equations don't change from one day to the next. In contrast, certain complex systems can undergo "tipping point" transitions, suddenly changing their behavior dramatically and perhaps irreversibly, with little warning and potentially catastrophic consequences.

On long enough timescales, most real-world systems are like this. Consider the Gulf Stream in the North Atlantic, which transports warm equatorial water northward as part of an oceanic conveyor belt that helps regulate Earth's climate. The equations that describe these circulating currents are slowly changing due to the influx of fresh water from melting ice sheets. So far the circulation has slowed gradually, but decades from now it may abruptly grind to a halt.

"Suppose everything is OK now," said Ying-Cheng Lai, a physicist at Arizona State University. "How do you tell that it's not going to be OK in the future?"

In a series of recent papers, researchers have shown that machine learning algorithms can predict tipping-point transitions in archetypal examples of such "nonstationary" systems, as well as features of their behavior after they've tipped. The surprisingly powerful new techniques could one day find applications in climate science, ecology, epidemiology and many other fields.

A surge of interest in the problem began four years ago with groundbreaking results from the group of Edward Ott, a leading chaos researcher at the University of Maryland. Ott's team found that a type of machine learning algorithm called a recurrent neural network could predict the evolution of stationary chaotic systems (which don't have tipping points) stunningly far into the future. The network relied only on records of the chaotic system's past behavior — it had no information about the underlying equations.

The network's learning approach differed from that of deep neural networks, which feed data through a tall stack of layers of artificial neurons for tasks like speech recognition and natural language processing. All neural networks learn by adjusting the strength of the connections between their neurons in response to training data. Ott and his collaborators used a less computationally expensive training method

A custom-built machine learning algorithm can predict when a complex system is about to switch to a wildly different mode of behavior.

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called reservoir computing, which adjusts only a few connections in a single layer of artificial neurons. Despite its simplicity, reservoir computing seems suited to the task of predicting chaotic evolution.

Impressive as the 2018 results were, researchers suspected that machine learning's data-driven approach wouldn't be able to predict tipping-point transitions in nonstationary systems or infer how these systems would behave afterward. A neural network trains on past data about an evolving system, but "what's happening in the future is evolving by different rules," said Ott. It's like trying to predict the outcome of a baseball game only to find that it's morphed into a cricket match.

And yet, in the past two years, Ott's group and several others have shown that reservoir computing works unexpectedly well for these systems too.

In a 2021 paper, Lai and collaborators gave their reservoir computing algorithm access to the slowly drifting value of a parameter that would eventually send a model system over a tipping point — but they provided no other information about the system's governing equations. This situation pertains to a number of real-world scenarios: We know how the carbon dioxide concentration in the atmosphere is rising, for instance, but we don't know all the ways that this variable will influence the climate. The team found that a neural network trained on past data could predict the value at which the system would eventually become unstable. Ott's group published related results last year.

In a new paper, posted online in July and now undergoing peer review, Ott and his graduate student Dhruvit Patel explored the predictive power of neural networks that only see a system's behavior and know nothing about the underlying parameter responsible for driving a tipping-point transition. They fed their neural network data recorded in a simulated system while the hidden parameter was drifting, unbeknownst to the network. Remarkably, in many cases the algorithm could both predict the onset of tipping and provide a probability distribution of possible post-tipping-point behaviors.

Surprisingly, the network performed best when trained on noisy data. Noise is ubiquitous in real-world systems, but it ordinarily hinders prediction. Here it helped, apparently by exposing the algorithm to a wider range of the system's possible behavior. To take advantage of this counterintuitive result, Patel and Ott tweaked their reservoir computing procedure to enable the neural network to recognize noise as well as the system's average behavior. "That's going to be important for any approach that's trying to extrapolate" the behavior of nonstationary systems,

said Michael Graham, a fluid dynamicist at the University of Wisconsin, Madison.

Patel and Ott also considered a class of tipping points that mark an especially stark change in behavior.

Suppose the state of a system is plotted as a point moving around in an abstract space of all its possible states. Systems that undergo regular cycles would trace out a repeating orbit in the space, while chaotic evolution would look like a tangled mess. A tipping point might cause an orbit to spiral out of control but remain in the same part of the plot, or it might cause initially chaotic motion to spill out into a larger region. In these cases a neural network may find hints of the system's fate encoded in its past exploration of relevant regions of the state space.

More challenging are transitions in which a system is suddenly expelled from one region and its later evolution unfolds in a distant region. "Not only are the dynamics changing, but now you're wandering into territory you've never ever seen," explained Patel. Such transitions are typically "hysteretic," meaning they're not easily reversed — even if, say, a slowly increasing parameter that caused the transition is nudged down again. This kind of hysteresis is common: Kill one too many top predators in an ecosystem, for instance, and the altered dynamics might cause the prey population to suddenly explode; add a predator back again and the prey population stays elevated.

When trained on data from a system exhibiting a hysteretic transition, Patel and Ott's reservoir computing algorithm was able to predict an imminent tipping point, but it got the timing wrong and failed to predict the system's subsequent behavior. The researchers then tried a hybrid approach combining machine learning and conventional knowledge-based modeling of the system. They found that the hybrid algorithm exceeded the sum of its parts: It could predict statistical properties of future behavior even when the knowledge-based model had incorrect parameter values and therefore failed on its own.

Soon Hoe Lim, a machine learning researcher at the Nordic Institute for Theoretical Physics in Stockholm who has studied the short-term behavior of nonstationary systems, hopes the recent work will "serve as a catalyst for further studies," including comparisons between the performance of reservoir computing and that of deep learning algorithms. If reservoir computing can hold its own against more resource-intensive methods, that would bode well for the prospect of studying tipping points in large, complex systems like ecosystems and Earth's climate.

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"There's a lot to do in this field," Ott said. "It's really wide open."

Quanta Magazine, 15 September 2022

https://quantamagazine.com

"Lost" moon could explain several Saturn mysteries, say astronomers

2022-09-15

Saturn is home to several solar system mysteries. Using data from Cassini, astronomers now suggest a simple answer to a few questions – a lost moon once orbited the planet before being torn to shreds.

Saturn's most striking feature is its rings, made mostly of small chunks of ice. It was long thought that these rings were leftover material from the formation of Saturn itself some 4.5 billion years ago, but recent studies suggest they're much younger – between 10 and 100 million years old. If that's the case, they could have formed from an icy comet or moon that wandered too close.

A new study proposes that Saturn got its rings and tilt from a long-lost moon.

The planet also rotates tilted at a 27-degree angle, relative to the plane it follows as it orbits the Sun. This was long believed to be caused by the gravitational influence of the nearby Neptune, but closer inspection has revealed that Saturn is no longer in-step with its neighbor.

The astronomers on the new study have now proposed a story that explains both mysteries: Saturn used to have another moon. This hypothetical moon, which the team named Chrysalis, would have been roughly the size of the existing moon Iapetus, which spans about 1,470 km (913 miles) wide. Chrysalis, if it existed, would have orbited Saturn alongside the 83 current moons for billions of years.

But gravitational interactions with other large moons, like Titan and Iapetus, gradually made the orbit of Chrysalis more chaotic. About 160 million years ago, the doomed moon swung too close to Saturn, where it was ripped apart by the intense gravity. Most of the debris would have rained down on the planet, but some became stuck swirling around Saturn, forming the famous rings.

This look might actually be a relatively short phase in the planet's life – other studies suggest the rings will probably vanish in the next 100 million years or so. By then, Mars may become the solar system's new ring-bearer.

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So what of Saturn's tilt? The team says the gravitational influence of Chrysalis would have kept its tilt in resonance with Neptune, so the loss of the moon would have allowed the planet to drift to its current angle.

The researchers came up with this explanation using data gathered by Cassini during its final sweep, before it plunged into Saturn's atmosphere in 2017. The probe measured the gravitational field of the planet, which allowed the team to model the distribution of mass in its interior. From this, they were able to calculate that Saturn was only just out of sync with Neptune, suggesting it had been until recently.

Next, the astronomers investigated what it would take to nudge the planet out of this dance. They simulated the history of the orbits of Saturn's 83 moons, and found that it did work – but only if an 84th, rather large moon was added.

As neat an explanation as Chrysalis may be, the team acknowledges that it remains a hypothesis until further evidence can be found.

"It's a pretty good story, but like any other result, it will have to be examined by others," said jack Wisdom, lead author of the study. "But it seems that this lost satellite was just a chrysalis, waiting to have its instability."

The research was published in the journal Science.

New Atlas, 15 September 2022

https://newatlas.com

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