CHEMWATCH

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ASIA PACIFIC

IAEA says Fukushima visit 'very productive'

2022-02-18

Japan announced in April 2021 it planned to gradually discharge more than 1.25 million cubic metres of treated water into the sea, and requested the IAEA's assistance to help "ensure its safe and transparent implementation".

The task force consists of IAEA staff members as well as 11 international experts from countries including China, Argentina, Australia, Russia, South Korea and the USA.

Ahead of this week's mission - to Tokyo and Fukushima - the members examined safety related documents, including the implementation plan for the water discharge and the radiological environmental impact assessment.

"The task force mission was very productive. We received valuable information - and posed many questions - about all safety aspects of the planned water discharge in frank and open discussions, ranging from the undersea tunnel that will carry the water out to sea to the protection of workers at the site and the public at large," said Gustavo Caruso, a director within the IAEA Department of Nuclear Safety and Security and chairman of the task force.

In part used to cool melted nuclear fuel at Fukushima, the water is treated and purified through a process known as the Advanced Liquid Processing System (ALPS) and has then been stored in around 1000 tanks at the site.

ALPS removes most of the radioactive contamination, with the exception of tritium. The total tank storage capacity on site amounts to about 1.37 million cubic metres and all the tanks are expected to be full around mid-2022.

Japan's discharge of the water is expected to begin during the first half of 2023 but the entire operation could last for decades. In August last year, Tokyo Electric Power Company (Tepco) announced plans for the construction of an undersea tunnel, about one kilometre in length, for the discharge of the treated water.

Nearby countries have been alarmed by Japan's plan, but the IAEA says that the level of tritium in the water will be "well below national regulatory limits and the World Health Organization standards for drinking water. The

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IAEA Task Force review will provide the public, in Japan and beyond, with objective scientific information about the discharge".

Fifty litres of water from the tanks were collected during the task force's visit and will be analysed at IAEA laboratories in Austria and Monaco.

The IAEA will release a report on this week's mission "in about two months" and will also carry out follow-up missions to Japan this year and next, and a comprehensive report with conclusions will be published before the water release starts.

Read More

World Nuclear News, 18 February 2022

https://www.world-nuclear-news.org/Articles/IAEA-says-Fukushima-visit-very-productive

India delays implementation of four quality control orders

2022-02-24

India's Department of Chemicals and Petrochemicals (DCPC) has delayed the implementation of quality control orders on four substances. The QCOs, issued by the Bureau of Indian Standards (BIS), will now enter into force in August, instead of February as originally planned .

The substances are:

- acetic acid – used as an ingredient in the manufacture of vinegar, household cleaning agents, textile processing, printing processes and as a chemical reagent;
- aniline – used to manufacture urethane foam, and in petrochemical processing, industrial explosives and as a dye intermediate;
- methanol – used as a gasoline additive and in the production of acetic acid and anti-freeze; and
- morpholine – used as a fruit preservation, a fungicide in cereals and as an ingredient in waxes, polishes and cleaners.

The QCO for morpholine will now enter into force on 1 August, while the others will become effective two days later.

In the intervening period, manufacturers, importers and traders across the value chain of the four chemicals can continue to operate and trade without interruption under the prevailing regulations.

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Until the QCOs come into force, the substances will have to carry the currently correct BIS Indian Standard (IS) specification numbers and markings on their packaging and labels

Official notification of the delays was published in the *Government Gazette* on 31 January, and subsequently circulated via the DCPC's website on 21 February.

Read More

Chemical Watch, 24 February 2022

https://chemicalwatch.com/426179/india-delays-implementation-of-four-quality-control-orders

Molinate reconsideration completed

2022-02-25

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has completed its reconsideration of molinate, a pesticide used exclusively for the control of barnyard grass and silver top grass in flooded rice paddies in Australia.

Following a review of the latest scientific information, the APVMA is satisfied products containing molinate can be used safely in accordance with updated label directions to ensure safe levels of exposure are not exceeded.

The updated label directions will:

- restrict the application methods to aerial application via SCWIIRT technology by helicopter or Bickley boom by fixed wing aircraft
- remove the highest application rate (5.2 L/ha)
- include specific instructions on how the products must be handled and limits on the amount of product a person can handle per day to ensure safe levels of exposure are not exceeded. This change also requires that the person mixing and loading the product is not the same person that is applying the product (i.e. the pilot)
- be updated to include buffer zones to account for spray drift on to sensitive areas in accordance with the APVMA's current approach to spray drift.

The APVMA will vary the most recent labels for molinate products to include the updated directions. Older stock bearing the previous label can

be legally used for up to 2 years following the date of the variation of the old label.

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APVMA, 25 February 2022

https://apvma.gov.au

Thailand Amends Rules on Application for Permit of Type 3 Hazardous Substance

2022-02-23

On February 11, 2022, Thailand's Department of Industrial Works (DIW) announced to solicit public comments for the draft amendments to the *Ministerial Regulation B.E 2537 (1994)* issued under *Hazardous Substance Act B.E. 2535 (1992)*, prescribing rules on the application for, or the issuance/modification of the permit of import/export/production/possession of Type 3 hazardous substance via online system. The consultation will be due on February 28, 2022. Once approved, this new ministerial regulation will come into force ninety days from the date of its publication on the Government Gazette.

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Chemlinked, 23 February 2022

https://chemical.chemlinked.com/news/chemical-news/thailand-amends-rules-on-application-for-permit-of-type-3-hazardous-substance

AMERICA

State & Federal Officials Move To Regulate & Even Ban PFAS Chemicals, But Many Wonder If That Makes Sense

2022-02-14

For federal and state lawmakers who have an unending procession of meeting requests, committee hearings, markups, fundraisers, and other demands on their schedules, time is perhaps the most valuable finite resource. For these reasons, what legislators choose to focus on is just as important as their policy preferences and positions.

Given the scarcity of time had by government officials, lawmakers' recent focus, both at the state and federal levels, on a group of chemicals, has

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struck many as misplaced and unnecessarily costly while others feel quite the opposite. Per- and Polyfluoroalkyl substances, widely referred to by the acronym PFAS, are "a group of manufactured chemicals that have been used in industry and consumer products since the 1940s because of their useful properties," explains the Environmental Protection Agency (EPA), which points out that there "are thousands of different PFAS, some of which have been more widely used and studied than others."

The desire to regulate, and possibly prohibit, the use of PFAS chemicals is primarily based on concerns over water contamination. Yet the EPA does not list PFAS among the main threats to water quality. According to the CDC, "human health effects from exposure to low environmental levels of PFAS are uncertain." Additionally, recent reports show that bodies of water contain only trace amounts of PFAS and have been declining. State and federal legislators are moving forward with new regulations and even total bans on certain PFAS chemicals despite the uncertainty surrounding potential health threats posed by PFAS chemicals, or even an agreement as to which chemical compounds fall under the PFAS umbrella.

Read More

Forbes, 14 February 2022

https://www.forbes.com/sites/patrickgleason/2022/02/14/state--federal-officials-concurrently-move-to-regulate--even-ban-an-entire-category-of-chemicals-but-many-wonder-whether-that-makes-sense

Oregon adds five new chemicals to HPCCCH list

2022-02-08

On 1st January 2022, the following five chemicals were added to the list of high priority chemicals of concern for children's health (HPCCCH). The Oregon Health Authority (OHA) announced a Permanent Rule Revision to Clarify Reporting and Revise Reportable Chemical List related to the Toxic Free Kids Act.

Entry	Chemical	CAS no	PQL (ppm)	Method
14	Dicyclohexyl phthalate (DCHP)	84-61-7	25.0	CPSC-

Entry	Chemical	CAS no	PQL (ppm)	Method
16	Diisobutyl phthalate (DIBP)	84-69-5	25.0	CPSC-
52	Bisphenol F (BPF)	620-92-8	1.0	Total Extraction/ EPA 1694
56	Ethylhexyl diphenyl phosphate (EHDPP)	1241-94-7	50.0	Total Extraction/ GC-MS
72	Chlorinated paraffins	108171-26-2	50.0	Total Extraction/ GC-MS

It entered in force on 1st January 2022.

Read More

Eurofins, 8 February 2022

https://www.eurofins.com/consumer-product-testing/media-centre/news/regulatory-updates-02-2022/

EPA axes pentachlorophenol wood preservative

2022-02-11

Companies can produce, distribute, and sell the wood preservative pentachlorophenol in the US for only 2 more years, the US Environmental Protection Agency announced Feb. 4. Wood treatment facilities, however, have until 2027 to use up their existing stocks of the chemical. The National Toxicology Program lists pentachlorophenol as a "reasonably anticipated" human carcinogen. It is banned under the United Nations' Stockholm Convention on Persistent Organic Pollutants, an international treaty the US signed but has not ratified. The EPA claims that pentachlorophenol poses health risks to workers. Alternative wood preservatives—including chromated arsenicals, copper naphthenate, creosote, and dichloro-octyl-isothiazolinone—are available, the EPA says. Environmental groups have been urging the EPA for decades to ban pentachlorophenol. The chemical is persistent in the environment and contaminates about 250 Superfund hazardous waste sites where it was made, according to the advocacy group Beyond Pesticides.

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C&EN, 11 February 2022

https://cen.acs.org/policy/chemical-regulation/EPA-axes-pentachlorophenol-wood-preservative/100/i6

Banning toxic chemicals in cosmetics moves forward in WA

2022-02-21

A type of chemical that Washington state already bans in firefighting foam is something you're still able to use on your face — but that may not remain the case for long.

A measure advancing in Washington's Legislature would ban the use of perfluoroalkyl and polyfluoroalkyl substances, or PFAS, in cosmetics. These chemicals are often used to make beauty products — such as mascara, foundation, and lipstick — water-resistant and longer lasting.

In high amounts, the chemicals may also increase cholesterol levels, hamper immune responses, cause pregnancy complications and increase the risk for certain types of cancers, according to the Centers for Disease Control and Prevention.

Senate Bill 5703 would ban the sale and distribution of cosmetics with added PFAS in Washington state starting Jan. 1, 2025. The measure would also ban adding other chemicals, including formaldehyde and mercury, to cosmetics, while setting limits for how much lead can be present in beauty products.

The proposal comes four years after state lawmakers voted to stop the sale and distribution of firefighting foam that include PFAS, and also voted to restrict the use of PFAS in food packaging.

While those bans are being phased in and have some exemptions, state Sen. Mona Das, D-Kent, said there's no reason the same chemicals should be allowed to be added to cosmetics.

"We have already banned this in our state for firefighters. Why are we not banning this for 50% of our population?" said Das, the prime sponsor of SB 5703.

"This is a banned chemical, it's a known carcinogen — and here we are putting it on the faces of women," she said.

Read More

Crisscut, 21 February 2022

https://crosscut.com/politics/2022/02/banning-toxic-chemicals-cosmetics-moves-forward-wa

EUROPE

EU Industry Days 2022: EU Chemical Industry Embarking on a Green Deal Transition Pathway

2022-02-18

Marking the start of a crucial journey, leaders from diverse backgrounds joined panels during the EU Industry Days 2022 to outline their expectations of the chemical industry's Transition Pathway; a co-creation process led by the European Commission aimed at accelerating industry towards the European Green Deal goals.

As global chemicals output is expected to double or even triple in the next decade, while limited growth is anticipated in Europe, Marco Mensink, Cefic Director General, addressed the double twin transition facing the European chemicals industry; to become climate neutral, increase circularity, digitalise, and implement the Chemical Strategy for Sustainability, whilst also remaining globally competitive. He asked, "how can we build a pathway so that investments in new technologies happen in Europe?" As a specialty chemicals region generating 40 billion euros in value, Marco called for close attention to be given to the small and medium-sized (SME) companies that depend on a strong European market.

Martin Brudermüller, CEO of BASF and Cefic President, echoed concerns as an ambassador of SMEs who hears "cries of help" from small companies as they prepare to transform. "We need confidence and investment security for European industry, and we need to generate the business case, or the transition will simply not work" he said.

The Transition Pathway comes at a very good time said Rafael Cayuela, Chief Strategy Officer and Corporate Chief Economist at Dow, referring to the second largest recession Europe has witnessed this century. The challenges are massive, as is the need for innovation in the industrial transformation "we don't have the time, and we don't have resources or innovation to be wasted," he noted.

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Acknowledging the vital role of chemicals to many value chains and enabling products for the transition, Johan Landfors, President of Technology Solutions at Nouryon, recognized that while alternative chemicals do exist, the right chemistry is needed. He said "New chemistry takes time. We need to drive innovation and have the right framework to ensure it's done in a proper way".

And from a company that has successfully transformed its operations over the past decade while remaining resilient and profitable, Mercedes Alonso, Executive Vice President, Renewable Polymers and Chemicals at Neste, outlined critical factors for the chemicals industry. She called for industry to jointly progress with its entire value chain, to take risks as "we don't have time to lose" and to "stop looking for the silver bullet"; it will take all kinds of solutions to combat the climate crisis.

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Energy Industry Review, 18 February 2022

https://energyindustryreview.com/energy-efficiency/eu-industry-days-2022-eu-chemical-industry-embarking-on-a-green-deal-transition-pathway/

INTERNATIONAL

EU Industry Days 2022: EU Chemical Industry Embarking on a Green Deal Transition Pathway

2022-02-18

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Energy Industry Review, 18 February 2022

https://energyindustryreview.com/energy-efficiency/eu-industry-days-2022-eu-chemical-industry-embarking-on-a-green-deal-transition-pathway/

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Appendix for nanoforms applicable to the Guidance on Registration and Substance Identification

2022-02-22

This guidance has been developed to provide advice to registrants for substances that cover "nanoforms". Section 2 of the guidance explains general requirements regarding the registration of nanoforms.

Section 3 explains the concept of nanoform, how to distinguish one nanoform from another and the characterisation requirements when registering individual nanoforms.

Section 4 focuses on how to create and justify sets of similar nanoforms and details the characterisation and reporting requirements when registering sets of nanoforms instead of individual nanoforms.

Section 5 describes the registration process and illustrates the concepts of nanoforms and sets of nanoforms in the context of a joint submission. It also explains important principles related to the joint vs. separate submission of REACH Annex VII-X information.

Read More

ECHA, 20 February 2022

https://echa.europa.eu/documents/10162/17250/how_to_register_nano_en.pdf

This guidance has been developed to provide advice to registrants for substances that cover "nanoforms". Section 2 of the guidance explains general requirements regarding the registration of nanoforms.

Janet's Corner

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Cells

2022-03-04

https://xkcd.com/1217/

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Hazard Alert

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Heptachlor

2022-03-04

Heptachlor, chemical formula $C_{10}H_5Cl_7$, is an organochlorine compound that was used as an insecticide. It is one of the cyclodiene insecticides. [1] Heptachlor is a white to light tan waxy solid with a camphor-like odour. It is insoluble in water and soluble in xylene, hexane, and alcohol. [2] Heptachlor was used extensively in the past for killing insects in homes, buildings, and on food crops. These uses stopped in 1988. [3] Due to its highly stable structure, heptachlor can persist in the environment for decades. [1] It is readily converted to more potent heptachlor epoxide once it enters the environment or the body. [4]

USES [5]

- Heptachlor is a constituent of technical grade chlordane, approximately 10 percent by weight.
- Heptachlor was used as an insecticide in the United States from 1953 to 1974. In 1974, nearly all registered uses of heptachlor were cancelled.
- Heptachlor was used from 1953 to 1974 as a soil and seed treatment to protect corn, small grains, and sorghum from pests. It was also used to control ants, cutworms, maggots, termites, and other pests in agriculture and in the home.
- Its sole U.S. manufacturer voluntarily cancelled the sale of heptachlor in 1987.
- In 1988, the sale, distribution, and shipment of existing stocks of all cancelled heptachlor and chlordane products were prohibited in the United States.
- The only commercial use of heptachlor products still permitted is fire ant control in power transformers. In addition, homeowner's use of existing stocks of heptachlor-containing termite control products is also allowed.

IN THE ENVIRONMENT [6]

- When heptachlor is released into the environment it is converted to heptachlor epoxide, which degrades more slowly and is thus more persistent.
- Heptachlor partitions somewhat rapidly to the atmosphere from surface water and that volatilisation is significant.

Heptachlor, chemical formula C10H5Cl7, is an organochlorine compound that was used as an insecticide.

- In contrast, heptachlor epoxide partitions slowly to the atmosphere from surface water.
- Heptachlor in water has an estimated half-life of 3.5 days.
- Heptachlor epoxide has a half-life in water of at least 4 years.
- Heptachlor and heptachlor epoxide adsorb strongly to sediments.
- Temperature and humidity affect the persistence of heptachlor and heptachlor epoxide in soil, as can the amount of organic matter present.
- Heptachlor and heptachlor epoxide are also taken up by plants and both may bioconcentrate in aquatic and terrestrial food chains.

SOURCES & ROUTES OF EXPOSURE

Sources of Exposure [5]

- People whose homes were treated for termites with heptachlor may be exposed to heptachlor in the indoor air for many years after treatment.
- Workers who use heptachlor to kill fire ants or who manufacture the chemical may be exposed to it in the air or through the skin.
- Heptachlor has been detected in food, including fish, shellfish, dairy products, meat, and poultry.
- Another possible source of exposure is drinking water; heptachlor has been detected at low concentrations in drinking water wells in several states.

Routes of Exposure [6]

- Inhalation – Minor route of exposure for the general population;
- Oral – Primary route of exposure is through the diet;
- Dermal – Minor route of exposure

HEALTH EFFECTS

Acute Effects

Acute inhalation exposure to heptachlor in humans has been associated with nervous system effects in a few case studies, while gastrointestinal effects, such as nausea and vomiting, have been reported to occur following accidental ingestion of heptachlor. Effects on the liver and central nervous system have been noted in animals acutely exposed to heptachlor via the oral route. Heptachlor is considered to have high to extreme acute toxicity based on short-term oral tests in rats.

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Chronic Effects

Chronic inhalation exposure to heptachlor has been associated with blood effects in humans, while oral exposure has resulted in neurological effects including irritability, salivation, dizziness, muscle tremors, and convulsions. Animal studies have reported effects on the liver, kidney, and the immune and nervous systems from oral exposure to heptachlor. The Reference Dose (RfD) for heptachlor is 0.0005 milligrams per kilogram body weight per day (mg/kg/d) based on liver weight increases in males rats only. EPA has not established a Reference Concentration (RfC) for heptachlor.

Reproductive/Developmental Effects

Heptachlor has been shown to cross the placenta to the developing foetus in humans. However, inadequate information is available to determine whether heptachlor may cause developmental or reproductive effects in humans. Animal studies have reported developmental effects, including foetal resorptions, and decreased postnatal survival, as well as reproductive effects such as failure of animals to reproduce, following oral exposure to heptachlor.

Cancer Risk

Human studies on heptachlor exposure and cancer are inconclusive. There are several case reports describing a possible link between heptachlor exposure and leukaemia and neuroblastoma; however, insufficient information is available to confirm a causal effect. Several studies on workers exposed via inhalation to heptachlor are available; however, these are limited due to confounding factors and small sample size. Animal studies have reported liver tumours in mice exposed to heptachlor via ingestion. EPA considers heptachlor to be a probable human carcinogen (cancer-causing agent) and has classified it as a Group B2 carcinogen.

SAFETY [7]

First Aid Measures

- Inhalation: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
- Ingestion: If swallowed, give large quantities of water to drink and get medical attention immediately. Never give anything by mouth to an unconscious person.

- Skin Contact: Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately. Wash clothing before reuse. Thoroughly clean shoes before reuse.
- Eye Contact: Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Exposure Controls & Personal Protection [8]

Exposure Controls

Methods that are effective in controlling worker exposures to heptachlor, depending on the feasibility of implementation, are as follows:

- Process enclosure
- Local exhaust ventilation
- General dilution ventilation
- Personal protective equipment

Personal Protective Equipment [9]

The following is a list of recommended personal protective equipment when handling heptachlor:

- Respiratory protection: Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN(EU).
- Hand protection: Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands. The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.
- Eye protection: Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

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- Skin and body protection: Complete suit protecting against chemicals, the type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

REGULATIONS [8,10]

United States

OSHA: The United States Occupational Safety and Health Administration permissible exposure limit (PEL) for heptachlor is 0.5 milligrams per cubic metre (mg/m^3) of air as an 8-hour time-weighted average (TWA) concentration. The OSHA PEL also bears a "Skin" notation, which indicates that the cutaneous route of exposure (including mucous membranes and eyes) contributes to overall exposure [29 CFR 1910.1000, Table Z-1].

NIOSH: The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) for heptachlor of 0.5 mg/m^3 as a TWA for up to a 10-hour workday and a 40-hour workweek. NIOSH also assigns a "Skin" notation to heptachlor. NIOSH considers heptachlor a potential occupational carcinogen [NIOSH 1992].

ACGIH: The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned heptachlor a threshold limit value (TLV) of 0.5 mg/m^3 as a TWA for a normal 8-hour workday and a 40-hour workweek. The ACGIH also assigns a "Skin" notation to heptachlor. The ACGIH lists heptachlor as an animal carcinogen [ACGIH 1994, p. 22].

Australia

Safe Work Australia: Safe Work Australia have established a time weighted average (TWA) for heptachlor of 0.5 mg/m^3 for a 40 hour work week.

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Solar hydropanel pulls 10 liters of clean drinking water per day out of the air

2022-02-22

By harvesting water vapor from the air and condensing it into liquid, atmospheric water generators can essentially pull water from the air, and these devices hold a lot of promise for providing an independent source of drinking water. And although drought-stricken regions and locations without safe or stable water sources are prime candidates for water production and purification devices such as those, residences and commercial buildings in the developed world could also benefit from their use, and they make a great fit for off-grid homes and emergency preparedness kits.

The statistics speak for themselves:

- 40 percent of America's 50,000 community water systems have had water quality violations, according to the EPA.
- 15 percent of Americans still rely on wells as their main source of water. A full 50 percent of that water wouldn't pass a quality test.
- Over 450,000 California residents who are served by a Community Water System are subjected to water that is failing to meet the Safe Drinking Water Act.
- Evidence shows that American households facing water insecurity and poor water quality are likely to have lower incomes and live in areas where infrastructure has been systemically underfunded.
- 100 percent of California's failing systems serve less than 100,000 people; 96.4 percent serve less than 10,000 people. Tulare County, where Allensworth is located, has largest number of systems without safe water. (Community Water Center's Drinking Water Tool identifies exactly where communities have the environmental burden of no clean water and are also disadvantaged.)
- The most common contaminants found in these water systems are arsenic, nitrate, lead, copper, Uranium, and E.Coli.

Some water generators, such as the WaterSeer, get a lot of hype (and a lot of skepticism) but haven't been able to deliver. Others, like the Ecoloblue devices, are a bit more costly and complex, but they actually exist and can be bought and put to work.

Zero Mass Water's device, is a rooftop solar device that produces water instead of just electricity. The company's hydropanel arrays are now

15 percent of Americans still rely on wells as their main source of water. A full 50 percent of that water wouldn't pass a quality test.

available in the US, where "It works in almost every climate, and almost every day of the year."

A standard array is made up of two hydropanels, with additional panels added as needed for the water production or the local climate, and this self-contained unit is designed to be mounted onto the roof of a building, where it can then produce an average of 4-10 liters per day. An onboard 30-liter reservoir holds the collected water and mineralizes it with calcium and magnesium, and the outflow of the device can be plumbed right to a tap (or refrigerator or dispenser) inside the building for ease of use. No maintenance is said to be necessary other than annual filter changes and swapping out the mineral cartridge every five years, which a subscription program delivers when it's time. The system will produce the equivalent of 43,800 bottles of water over its lifetime, with no plastic waste.

A Practical Solution

According to Zero Mass Water, even those in low-humidity and arid regions can put units to work to generate water, which is a question that many skeptics of the system bring up. "Our array on the Zero Mass Water headquarters in Scottsdale, Arizona makes water year-long despite low relative humidity. The Phoenix-Metro area can get below 5% relative humidity in the summer, and still produces water in these incredibly dry conditions."

Water generators are costly, at least in terms of the initial investment. A standard array with two panels runs about $4000, plus another $500 for installation, and is said to be engineered to last at least 10 years. That brings the cost to about $1.23 per day, or between $0.12 and $0.30 per liter, when averaged out over the life of the unit.

The Brighter Side, 22 February 2022

https://thebrighterside.news

As New Zealand's Omicron infections rise rapidly, genome surveillance is shifting gears

2022-02-23

Genomic sequencing has been a key tool throughout Aotearoa's COVID-19 pandemic, with data generated here now part of the 8.5 million genomes shared globally.

It has helped us understand how cases arrived here and the extent of community outbreaks. It has also given us detailed insight into how the

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virus is transmitted from person to person, on a plane or quarantine facility.

As Omicron spreads rapidly across the country, it is important to consider how we best deploy genomics to achieve our public health goals. Which cases should we sequence and why? What is the role of wastewater when we know cases are already in our cities and regions?

Even as our testing and genomics capacity gets overwhelmed by the sheer number of cases, sequencing will continue to play an important role.

Firstly, we need to keep an eye open for new viral variants and keep track of those already circulating in the community. This is a core role of genomic surveillance and part of a global effort, with scientists around the world sequencing variants in their backyard.

One thing we are looking for is changes (mutations) in the virus that may affect its ability to transmit, evade our vaccines or immune defences, or cause even more serious disease. Particular scrutiny is given to mutations in the viral spike protein, on the outside of the virus, which allows it to latch onto cells and infect them.

Particular scrutiny is given to mutations in the viral spike protein, on the outside of the virus, which allows it to latch onto cells and infect them.

The Pfizer vaccine we have used in Aotearoa essentially presents the body with a copy of the spike protein to train the immune system to create antibodies and other defences against it. Major changes in the spike might allow the virus to evade at least the first line of our immune defences — as we have seen with the Omicron variant, which contains more than 30 different mutations in the spike protein.

The viral arms race

With relatively few cases overall in New Zealand, and only the Delta variant that has persisted in the community for more than a few months, we have so far not seen any concerning new mutations or variants arise here. But small mutations or deletions in the virus's genetic code remain helpful for linking clusters and detecting new introductions into the community.

The majority of New Zealanders are now vaccinated, which means there is increasing pressure on the virus to escape our immunity. This is an arms race we have been playing with viruses for millennia. The game has changed somewhat as genomics allows us to watch viral evolution in real time.

By sequencing the virus from individual cases, we can tell exactly which variant the person has and, over time, we can detect patterns of variants rising in frequency or resulting in a more severe infection.

Currently, genomic surveillance tells us there is a mix of Omicron (including major variants BA.1, and BA.2) and a stubborn tail of Delta.

The BA.1 lineage was given an early boost at a wedding-related super-spreading event and now makes up 74% of Omicron cases. The remaining 26% of Omicron cases are BA.2 which was spread early on at the SoundSplash festival. In the last week, about 7% of cases sequenced were Delta. Without sequencing, we would be blind to this.

To maintain high-quality surveillance in the face of very high case numbers, we need to be selective in which samples we sequence and balance competing priorities. The top priority is the prevention of severe disease and there will be a focus on the genomes of cases in hospital. Overseas, many of the serious, hospitalised cases are Delta, not Omicron.

New variants of concern

Some patients may have the misfortune of chronic COVID-19 infections. In such cases, multiple samples may be sequenced to see if the virus is changing within a single patient.

A leading hypothesis of how variants of concern such as Omicron and Delta have emerged is via chronically infected patients who act as an incubator for the virus. We need to continue monitoring patients with long-haul COVID.

We will also need to continue to monitor and sequence new cases that arrive at the border, either in MIQ or in recently returned travellers who test positive. Nearly all the genetic variation of SARS-CoV-2 we have seen in Aotearoa has been imported (as opposed to developed here), and this is a common pattern we see with other diseases such as influenza. By sequencing border cases, we get an early view of what we may need to prepare for.

Finally, to get a high-level view of cases and mutations, we sequence a random sample of cases across the country. Genomic sequences taken across time and space build a picture of which parts of the country are host to which variants and lineages. It is very much a case of "know thy enemy".

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Currently we are monitoring the areas where Delta is persisting. We can also monitor how the vaccine status of an individual affects the variant that is detected. Such data helps to build a picture of vaccine efficacy and population-level protection against a fast-changing virus.

Wastewater testing

The last piece of the genomic sequencing puzzle is wastewater testing for SARS-CoV-2. While sequencing from wastewater samples has been used for specific public health investigations in the past, low case numbers and quantities in most wastewater samples has made it difficult. Instead, wastewater testing has focused on using a sensitive method to allow for the early detection of the virus.

With the Omicron surge, we are now seeing an increase in both the number of positive wastewater samples and the amount of virus in those samples. This means we can use wastewater to indicate increasing or decreasing trends in cases at community level, and also to monitor known and new variants through sequencing and other tools.

In the weeks to come, there will be enough viral matter to make trends in wastewater data evident. In some cities, where regular sampling occurs, we will see viral wastewater loads trending up and down with case numbers. This information, along with regular case reporting, will inform the public about the relative risk of various regions. Such data may help people to understand the risks of travelling to a certain region or city.

Genomics remains a key tool in our pandemic management. There will be changes in how we use it, but it remains a core part of our surveillance toolkit. Prior to the genomics era, changes in the viral genetic blueprint were invisible to us. While many will dread another story about a new variant, we would be in a far worse position without this information.

If we step outside of our COVID-19 bubble for a second, the use of fast and affordable genomic technology in this pandemic also provides a glimpse of what genomic medicine may look like in the future — but that is a discussion for another day.

The Conversation, 23 February 2022

https://theconversation.com

Diseased male livers undergo sex-change

2022-02-19

The livers of men diagnosed with hepatic diseases change sex as part of a potential self-protective mechanism, according to University of Queensland research.

Institute for Molecular Bioscience (IMB) lead researcher, Associate Professor Frederic Gachon said the surprise discovery was made during an investigation into why disruption of the body's circadian clock is associated with obesity, type 2 diabetes and liver diseases.

"When a high-fat diet was fed to mice that had their circadian clock gene turned off, we expected them to develop diabetes or non-alcoholic fatty liver disease (NAFLD) like the control mice, but they didn't," Dr Gachon said.

"We also found that the liver of the obese male mice had been feminised probably due in part to the protective nature of the female sex hormone, oestrogen."

Like reproductive organs, the liver is sexually dimorphic, which means there are significant differences between the metabolic function of male and female livers.

The team then went on to study human samples and got the same results.

"The more advanced the disease, the more feminisation we saw in the liver tissue," Dr Gachon said.

"It appears that the disruption of circadian rhythms might be protecting the liver by influencing the levels of hormones such as growth hormone, oestrogen and testosterone."

The internal body clock controls many biological functions including sleep, hormone secretion, body temperature and metabolism.

NAFLD is far more prevalent in men and affects 25 per cent of the adult population, while sleep disorders are known symptoms of the disease.

"This study suggests that the disruption of the circadian clock gives the body flexibility in metabolic pathways that can help to slow down disease progression," Dr Gachon said.

Like reproductive organs, the liver is sexually dimorphic, which means there are significant differences between the metabolic function of male and female livers.

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"In light of these findings, we are investigating whether behavioral and hormonal interventions are possible treatments for liver disease."

University of Queensland, 22 February 2022

https://uq.edu.au

Repurposing offshore oil and gas rigs

2022-02-08

Decommissioning offshore oil and gas rigs — wherein offshore oil and gas activities cease operation due to safety concerns or obsolescence, among other reasons — is both costly and time consuming.

Typically, oil and gas decommissioning entails several steps, including:

- Plugging all of the wells associated with the platform and severing the well casings 15 ft below the mudline;
- Cleaning and dismantling all production and pipeline risers associated with the platform;
- Dismantling the platform from its foundation by severing all components at least 15 ft below the mudline;
- Disposing of the platform components in a scrap yard or fabrication yard, or placing the platform components at an artificial reef site;
- Conducting site clearance verification at the platform, ensuring that no debris or potential obstructions remain.

With so many different steps involved, costs to consider and the increasing number of oil and gas platforms reaching their end-of-life, creative solutions for reusing existing offshore oil and gas structures have been quick to emerge. This article explores a handful of the solutions under consideration for repurposing offshore oil and gas platforms. Follow along with Engineering360 as it explores some possible alternative uses for these inactive structures.

Artificial reefs

Turning oil and gas offshore platforms into artificial reefs is one such creative idea floated to those preparing to decommission offshore structures. Specifically, Rigs-to-Reefs is a program that involves the donation of decommissioned oil and gas platforms to serve as artificial reefs that attract organisms (barnacles and bivalves for instance). The reuse of these structures reportedly provides benefits for the marine environment by enhancing fish habitats.

With so many different steps involved, costs to consider and the increasing number of oil and gas platforms reaching their end-of-life, creative solutions for reusing existing offshore oil and gas structures have been quick to emerge.

Some methods for transforming an existing structure into an artificial reef include toppling the platform in place, removing only part of the platform or severing the structure from the sea floor and towing it to an approved location.

Hotels

Decommissioned oil and gas platforms could, in the future, serve as a recreational destination of sorts for tourists. Saudi Arabia's sovereign wealth fund, the Public Investment Fund (PIF), has announced plans for the development of a resort destination inspired by oil and gas platforms.

The resort, appropriately dubbed The Rig, will reportedly feature three hotels, 800 rooms and 11 restaurants spread across a 1.6 million sq ft offshore platform in the Persian Gulf. In addition to accommodations, the resort is also expected to feature water slides, a roller coaster, a Ferris wheel, bungee jumping, scuba diving, a performance venue and more. The resort will be accessible by boat, yacht, cruise ship or helicopter, according to the PIF.

More information about The Rig is featured in the accompanying promotional video that appears courtesy of the PIF.

Fish farming

Dutch company Jack-Up Barge and Norwegian firm Roxel Aqua are joining forces to transform aging oil and gas rigs into feeding and harvesting facilities for the salmon farming industry.

The proposed design, dubbed the Octopus, will feature a modified jack-up rig — an oil and gas barge with long support legs that can be lowered and raised — surrounded by 12 to 14 submersible salmon cages.

To transform the oil and gas platform, the companies propose removing the drilling module and installing a fish process module, a lice removal unit and sub surface cages, which can be lowered via winches when storms are forecast.

The repurposed oil and gas rigs are being proposed for locations off the coasts of Scotland, Norway and Australia.

For more on the proposal, watch the accompanying video that appears courtesy of Roxel Aqua.

A launchpad

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Two decommissioned oil drilling rigs in the Gulf of Mexico may soon be converted into offshore launchpads for rockets destined for Earth's orbit, the moon and even Mars.

According to reports, the two 240 ft x 255 ft submersible oil rigs located in Brownsville, Texas, will be converted into launchpads by SpaceX, the American aerospace manufacturer and space transportation services company founded by Elon Musk.

Formerly dubbed ENSCO 8500 and ENSCO 8501, the oil rigs have been renamed Phobos and Deimos — in a nod to the two moons of Mars — potentially hinting at their intended future application as rocket launchpads.

Future homes

A Paris design firm has released a concept that would turn decommissioned offshore oil rigs into residences of the future, according to reports.

The concept design, which is part of XTU Architect's project X_Lands, includes outfitting the decommissioned platforms in so-called housing units in a bubble-like design.

Covered in plants, the floating platforms would be entirely self-sustained, generating their own clean energy via solar and wind power. Additionally, space on the platform would be dedicated to growing food for those who live there.

The X-Lands project aims to envision a future after oil when the only reminders of the industry are in the abandoned oil platforms located all over the world.

Carbon dioxide pumping and storage

University of Edinburgh researchers have determined that offshore oil and gas platforms could be repurposed as pumping stations for sub-seabed carbon dioxide storage sites.

Researchers applied a computer model to data for a depleted hydrocarbon field located off the northeast coast of Scotland and discovered that retrofitting the platform as a pumping station would be 10 times cheaper than the cost of decommissioning. According to the research team, natural gas and thermal energy extracted from the associated saline formation could potentially be exploited for fuel or electricity production, and mixing saltwater from the oil field with the CO2 produced by burning the gas

encourages its injection deep underground for permanent safe storage into the porous rock formation.

These are just a few examples of how creative solutions are being devised to prepare offshore oil and gas platforms, nearing their end of life, for some other future use

Engineering 360, 8 February 2022

https://insights.globalspec.com

Shark-skin-inspired film immediately drops airliner fuel consumption

2022-02-23

Zero-emissions airliners are still a long way off, but Lufthansa and BASF have developed a way to improve things right now. AeroShark is an adhesive riblet film that immediately reduces fuel consumption, and therefore emissions, from any aircraft.

Millions of years of evolution moved the ocean's most feared predators away from perfectly smooth skin. Instead, sharks have very slightly ribbed skin, which reduces drag enough to become an advantage. What works in hydrodynamics often translates well to aerodynamics, so the AeroShark team moved to emulate the texture on the exterior of large aircraft.

Sharks have very slightly ribbed skin, which reduces drag enough to become an advantage.

The resulting film doesn't sound like a radical difference; the millions of prism-shaped "riblets" on the AeroShark film's surface are no more than 50 micrometers (1/20th of a millimeter, 2/1000ths of an inch) high. But that's enough to make a difference in fuel consumption; international airline Swiss has calculated that if 950 square meters (10,225 sq ft) of this film is applied to a Boeing 777, in specific patterns and aligned with the airflow around the fuselage and engine nascelle surfaces, the reduced drag immediately reduces fuel consumption by 1.1 percent.

Thus, Swiss is sticking AeroShark on all 12 of its 777s, in a move it says will save a staggering 4,800 tonnes of jet fuel a year, reducing CO2 emissions by some 15,200 tonnes in the process. Lufthansa had previously announced it will roll it out on its entire cargo freight fleet as well – a further 10 Boeing 777s, representing 3,700 tons of jet fuel savings and 11,700 tonnes of CO2 emissions avoided every year. The AeroShark team says it's likely to be slightly more effective on cargo planes that don't have window rows to work around.

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The team says it's easy to apply, and extremely resilient to UV radiation, water, oil, and the large temperature and pressure shifts you get on the exterior of long-haul aircraft. It's already been tested with more than 1,500 flight hours, on a Boeing 747-400, a modification that was certified by EASA. Applying it to wing surfaces can also help generate extra lift.

Lufthansa Technic and BASF are working to develop the technology further and roll out applications for other aircraft types, and the team says this sharkskin-inspired film could eventually be improved to reduce fuel burn and emissions by up to 3 percent.

Clearly, this kind of drag reduction tech will have relevance beyond the current era of kerosene-powered flight as well.

News Atlas, 23 February 2022

https://newsatlas.com

Perovskite artificial retina can read handwritten numbers

2022-02-23

Researchers have built an artificial retina out of perovskite materials that can detect light in a similar fashion to the human eye. In tests, the device was even able to recognize handwritten numbers.

The eyes of humans and other mammals work thanks to photoreceptor cells – the rods and cones – in the retina.

The eyes of humans and other mammals work thanks to photoreceptor cells – the rods and cones – in the retina, which absorb incoming photons and send electrical signals to the brain. For the new study, researchers at KAUST set out to mimic that process in an artificial device.

The key ingredient is perovskite, a material that's very efficient at absorbing light, and as such is emerging as a frontrunner in the next generation of solar cells. In this case, the team harnessed that light-absorbing prowess to make a sensor instead.

Perovskite nanocrystals were embedded onto a polymer, then that layer was sandwiched between two electrodes – aluminum on the bottom and indium tin oxide on the top. This upper electrode was etched to let light through to the perovskite layer, creating an array of photoreceptors. These are made on a polyimide substrate that lets the device flex and bend into whatever shape is needed, such as that of the human retina.

To process the light input, this photoreceptor array was attached to a CMOS sensor and a neural network with 100 output neurons. In tests with

a 4 x 4 array, the device was illuminated using LEDs of various colors and it was found that the optical response was very similar to that of the human eye, with the system particularly sensitive to green light. In other tests, the system was even able to recognize handwritten numbers with an accuracy of 72 percent. It was also very stable, with no change in the response to light after 129 weeks.

Despite its biological inspiration, this artificial retina isn't likely to be destined for human transplants like some others. The team says that with more development, this device would be used to make more advanced vision systems for cameras and robots.

"The ultimate goal of our research in this area is to develop efficient neuromorphic vision sensors to build efficient cameras for computer vision applications," said Khaled Nabil Salama, corresponding author of the study. "Existing systems use photodetectors that require power for their operation and thus consume a lot of energy, even on standby. In contrast, our proposed photoreceptors are capacitive devices that don't consume static power for their operation."

News Atlas, 23 February 2022

https://newsatlas.com

World's nations start to hammer out first global treaty on plastic pollution

2022-02-23

Each year, an estimated 11 million tons of plastic waste enter the ocean, equivalent to a cargo ship's worth every day. The rising tide—in the oceans and beyond—is just a symptom of much wider problems: unsustainable product design, short-sighted consumption, and insufficient waste management, scientists say. To curb the flood, says Jenna Jambeck, an environmental engineer at the University of Georgia, "we need to take more action and it needs to be further upstream" in the production process.

That's exactly what negotiators from 193 countries are setting out to do when they meet in Nairobi, Kenya, next week. Their ambitious goal: to create a negotiating committee that will try to hammer out, within 2 years, a new global treaty intended to curb plastic pollution.

An already released proposal, modeled on the United Nations's climate treaty, would have nations adopt action plans, set binding waste reduction

"Ambitious" efforts could set waste reduction targets, establish scientific advisory body.

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targets, and establish monitoring systems and a new global scientific advisory body. "It's about time," says Chelsea Rochman, an ecologist at the University of Toronto who has called on nations to tackle the issue.

Existing international efforts to reduce marine litter and exposure to hazardous chemicals include some measures related to plastic pollution. But no global treaty tries to reduce pollution by targeting a product's entire life cycle, from its birth as a raw material to its death—if it becomes trash. Taking such a broad approach to plastics, says Anja Brandon, a policy analyst at the Ocean Conservancy, "is going to be a much bigger scientific endeavor."

For one thing, rigorous, comparable numbers on the scope and sources of the problem are scarce, making it difficult to identify pollution hot spots or detect trends. Nonprofit groups and government agencies use dozens of varying protocols for surveying beach litter, for example. Methods of counting microplastics in water—shed from synthetic fabrics, for example, or formed when large plastic objects degrade—also vary. "There are several holes in the data," Jambeck says.

The new treaty could help by promoting or establishing standard measuring and accounting methods. One such approach, called environmental economic accounting, is already being used in some countries to track various raw materials. And a method known as mass balance analysis, which tracks the amount of material entering and leaving production processes, holds promise for quantifying the amount of recycled plastic used in new products.

Even after scientists settle on standard metrics, collecting those numbers could be a challenge, Jambeck notes, especially in developing nations with relatively weak regulatory and research infrastructures. The United Nations Environment Programme (UNEP), which is hosting the upcoming meeting, has worked to increase monitoring capacity with training programs and online courses. Such efforts would be aided by a new treaty that encourages funding and technological advances. Remote sensing via satellites and drones, for example, could more easily identify plastic pollution trends, reducing the need for labor-intensive ground surveys.

More detailed industrial data on plastics production, transport, and consumption could also help nations curb pollution, researchers say. But many countries allow companies to keep such numbers private, making it difficult to calculate how plastic is moving through the economy and into the environment. And no one systematically tracks that information. The Ocean Conservancy, for example, has struggled to find out how

much recycled plastic firms are using, Brandon says. Researchers are still pondering which numbers would be most useful, and how the treaty might help make that information more available.

Negotiators will also confront a key question: How much plastic pollution is too much? It's clear that plastic bags, discarded fishing gear, and microplastics can kill wildlife, but scientists are just beginning to figure out how to calculate the risks. The treaty could help catalyze such efforts, says Rochman, who recently helped California regulators devise protocols for setting microplastic thresholds to protect people and ecosystems.

The political will to reduce plastic waste will be much higher if it's known to harm humans, says Karen Raubenheimer, a policy researcher at the University of Wollongong. But she thinks any final agreement is unlikely to call for hard caps on new plastic. "It will be challenging in the short-term to stop using virgin plastic," Raubenheimer says.

A big reason is that many uses of plastic are seen as essential. Single-use plastic items are common in health care, for example, to prevent contamination and infections, and in the food industry to keep fruit, vegetables, and other products from spoiling. Even disposable bottles can be vital in areas without clean water.

Negotiators might call for the reduction or elimination of what UNEP has called "unnecessary, avoidable and problematic plastic," such as single-use shopping bags, takeout cutlery, or plastic beads in cosmetics. But analysts say nations must also focus on ways to reuse and recycle plastic materials. Currently, researchers estimate that less than 10% of plastic products are recycled. Smarter product designs that drive better waste management practices could boost that number, reducing the demand for virgin materials.

Trying to finalize the new treaty in just 2 years is "highly ambitious," UNEP admits. But researchers who have watched the plastic pile up are delighted that the talks are even getting started. "People are putting high level resources to try to solve this problem in a way that we didn't see a decade ago," says Kara Lavender Law, a physical oceanographer at the Sea Education Association. "It's actually astonishing."

Science, 23 February 2022

https://science.org

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Global warming is amplifying our water cycle—and it's happening much faster than we expected

2022-02-23

The global water cycle—that is, the constant movement of freshwater between the clouds, land and the ocean—plays an important role in our daily lives. This delicate system transports water from the ocean to the land, helping to make our environment habitable and soil fertile.

But rising global temperatures have been making this system more extreme: water is moving away from dry regions towards wet regions, causing droughts to worsen in parts of the globe, while intensifying rainfall events and flooding in others. In other words, wet areas are getting wetter, and dry areas are getting drier.

Up until now, changes to the cycle have been difficult to directly observe, with around 80 percent of global rainfall and evaporation happening over the ocean.

Up until now, changes to the cycle have been difficult to directly observe, with around 80 percent of global rainfall and evaporation happening over the ocean.

But a new UNSW-led study, published today in Nature, has used changing patterns of salt in the ocean to estimate how much ocean freshwater has moved from the equator to the poles since 1970. The findings show that between two and four times more freshwater has moved than climate models anticipated—giving us insights about how the global water cycle is amplifying as a whole.

"We already knew from previous work that the global water cycle was intensifying," says lead author of the study Dr. Taimoor Sohail, a mathematician and postdoctoral research associate at UNSW Science. "We just didn't know by how much.

"The movement of freshwater from warm to cold areas forms the lion's share of water transport. Our findings paint a picture of the larger changes happening in the global water cycle."

The team reached their findings by analyzing observations from three historical data sets covering the period 1970-2014.

But instead of focusing on direct rainfall observations—which can be hard to measure across the ocean—they focused on a more unusual aspect: how salty the water was in each ocean area.

"In warmer regions, evaporation removes fresh water from the ocean leaving salt behind, making the ocean saltier," says co-author Jan Zika, an associate professor in the UNSW School of Mathematics and Statistics.

"The water cycle takes that fresh water to colder regions where it falls as rain, diluting the ocean and making it less salty."

In other words, the water cycle leaves a signature on the ocean salt pattern—and by measuring these patterns, researchers can trace how the cycle changes over time.

The team estimate that between 1970 and 2014, an extra 46,000-77,000 cubic kilometers of freshwater was transported from the equator to the poles than expected—that's around 18-30 centimeters of freshwater from tropical and sub-tropical regions, or roughly 123 times the water in Sydney Harbour.

"Changes to the water cycle can have a critical impact on infrastructure, agriculture, and biodiversity," says Dr. Sohail. "It's therefore important to understand the way the climate change is impacting the water cycle now and into the future.

"This finding gives us an idea of how much this limb of the water cycle is changing, and can help us improve future climate change models."

Improving future projections

When Dr. Sohail and the team compared their findings to 20 different climate models, they found that all the models had underestimated the actual change in warm-cold freshwater transfer.

Dr. Sohail says the findings could mean we're underestimating the impacts of climate change on rainfall.

"Findings like ours are how we improve these models," says Dr. Sohail.

"Each new generation of modeling adapts past models with real data, finding areas that we can improve upon in future models. This is a natural evolution in climate modeling."

Scientists are now using the sixth generation of climate modeling (called the Sixth Climate Model Intercomparison Project, or 'CMIP6'), which incorporated updates from the fifth generation.

This newest finding is a demonstration of the scientific process at work—and could help improve future estimates.

"Establishing the change in warm-to-cold freshwater transport means we can move forward and continue to make these important projections

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about how climate change is likely to impact our global water cycle," says Dr. Sohail.

"In 10 or 20 years from now, scientists can use this reference to find out how much these patterns are further changing over time."

Phys Org, 23 February 2022

https://phys.org

Live wire: New research on nanoelectronics

2022-02-24

Proteins are among the most versatile and ubiquitous biomolecules on earth. Nature uses them for everything from building tissues to regulating metabolism to defending the body against disease.

Now, a new study shows that proteins have other, largely unexplored capabilities. Under the right conditions, they can act as tiny, current-carrying wires, useful for a range human-designed nanoelectronics.

In new research appearing in the journal ACS Nano, Stuart Lindsay and his colleagues show that certain proteins can act as efficient electrical conductors. In fact, these tiny protein wires may have better conductance properties than similar nanowires composed of DNA, which have already met with considerable success for a host of human applications.

Professor Lindsay directs the Biodesign Center for Single-Molecule Biophysics. He is also professor with ASU's Department of Physics and the School of Molecular Sciences.

Just as in the case of DNA, proteins offer many attractive properties for nanoscale electronics including stability, tunable conductance and vast information storage capacity. Although proteins had traditionally been regarded as poor conductors of electricity, all that recently changed when Lindsay and his colleagues demonstrated that a protein poised between a pair of electrodes could act as an efficient conductor of electrons.

The new research examines the phenomenon of electron transport through proteins in greater detail. The study results establish that over long distances, protein nanowires display better conductance properties than chemically-synthesized nanowires specifically designed to be conductors. In addition, proteins are self-organizing and allow for atomic-scale control of their constituent parts.

Under the right conditions, [proteins] can act as tiny, current-carrying wires, useful for a range human-designed nanoelectronics.

Synthetically designed protein nanowires could give rise to new ultra-tiny electronics, with potential applications for medical sensing and diagnostics, nanorobots to carry out search and destroy missions against diseases or in a new breed of ultra-tiny computer transistors. Lindsay is particularly interested in the potential of protein nanowires for use in new devices to carry out ultra-fast DNA and protein sequencing, an area in which he has already made significant strides.

In addition to their role in nanoelectronic devices, charge transport reactions are crucial in living systems for processes including respiration, metabolism and photosynthesis. Hence, research into transport properties through designed proteins may shed new light on how such processes operate within living organisms.

While proteins have many of the benefits of DNA for nanoelectronics in terms of electrical conductance and self-assembly, the expanded alphabet of 20 amino acids used to construct them offers an enhanced toolkit for nanoarchitects like Lindsay, when compared with just four nucleotides making up DNA.

Transit Authority

Though electron transport has been a focus of considerable research, the nature of the flow of electrons through proteins has remained something of a mystery. Broadly speaking, the process can occur through electron tunneling, a quantum effect occurring over very short distances or through the hopping of electrons along a peptide chain—in the case of proteins, a chain of amino acids.

One objective of the study was to determine which of these regimes seemed to be operating by making quantitative measurements of electrical conductance over different lengths of protein nanowire. The study also describes a mathematical model that can be used to calculate the molecular-electronic properties of proteins.

For the experiments, the researchers used protein segments in four nanometer increments, ranging from 4-20 nanometers in length. A gene was designed to produce these amino acid sequences from a DNA template, with the protein lengths then bonded together into longer molecules. A highly sensitive instrument known as a scanning tunneling microscope was used to make precise measurements of conductance as electron transport progressed through the protein nanowire.

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The data show that conductance decreases over nanowire length in a manner consistent with hopping rather than tunneling behavior of the electrons. Specific aromatic amino acid residues, (six tyrosines and one tryptophan in each corkscrew twist of the protein), help guide the electrons along their path from point to point like successive stations along a train route. "The electron transport is sort of like skipping stone across water—the stone hasn't got time to sink on each skip," Lindsay says.

Wire wonders

While the conductance values of the protein nanowires decreased over distance, they did so more gradually than with conventional molecular wires specifically designed to be efficient conductors.

When the protein nanowires exceeded six nanometers in length, their conductance outperformed molecular nanowires, opening the door to their use in many new applications. The fact that they can be subtly designed and altered with atomic scale control and self-assembled from a gene template permits fine-tuned manipulations that far exceed what can currently be achieved with conventional transistor design.

One exciting possibility is using such protein nanowires to connect other components in a new suite of nanomachines. For example, nanowires could be used to connect an enzyme known as a DNA polymerase to electrodes, resulting in a device that could potentially sequence an entire human genome at low cost in under an hour. A similar approach could allow the integration of proteosomes into nanoelectronic devices able to read amino acids for protein sequencing.

"We are beginning now to understand the electron transport in these proteins. Once you have quantitative calculations, not only do you have great molecular electronic components, but you have a recipe for designing them," Lindsay says. "If you think of the SPICE program that electrical engineers use to design circuits, there's a glimmer now that you could get this for protein electronics."

Phys Org, 24 February 2022

https://phys.org

Study sheds light on axion dark matter

2022-02-23

Scientists from Durham University and Kings College London have presented a theoretical review in a new study strongly supporting the search for axion dark matter.

The identity of dark matter, which makes up 85% of the matter in the universe, is one of the big unanswered questions in particle physics.

Scientists know of its existence because of its gravitational pull effects on stars and galaxies but what kind of particle it is, still remains a mystery.

The researchers analyzed how axions can be described mathematically and presented how they relate to the fundamental symmetries of the Standard Model of particle physics.

The axion explains why the strong interaction—the force that binds together quarks in protons and neutrons—obeys time reversal symmetry. This means that, at the subatomic level, processes caused by the strong interaction would look the same if the direction of time was reversed.

Why the strong interaction obeys time reversal symmetry is still unknown. The axion is a popular solution to this mystery.

Axion dark matter behave more like a field covering the universe than like individual particles. In the early universe, the value of the axion field begins to oscillate back and forth. The energy stored in these oscillations is axion dark matter.

It is known that dark matter of any kind can only interact very weakly with light, or else it would have been seen by scientists already. Axion dark matter interacts with light very weakly, but by looking closely at telescope observations the researchers might be able to see signs of this interaction.

For example, a photon (a particle of light) traveling through a magnetic field would have a small probability of turning into an axion. This process would cause unusual features in telescope observations of galaxies shining through magnetic fields.

The full analysis of the study was published in Science Advances. A companion review paper—"Axion Dark Matter: How to see it?" by Yannis Semertzidis and SungWoo Youn—shows how the axion could be detected in the lab soon.

The identity of dark matter, which makes up 85% of the matter in the universe, is one of the big unanswered questions in particle physics.

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Study co-author, Dr. Francesca Chadha-Day, said: "It is a very exciting time to be an axion physicist. Nobody yet knows the identity of dark matter. By searching for different possibilities, such as the axion, we hope to one day solve this mystery."

The researchers hope that this review will increase interest and understanding of axion physics within the broader community of physicists and scientists.

Phys Org, 23 February 2022

https://phys.org

Turning PPE into water: sounds like a miracle?

2022-02-16

Turning non-recyclable personal protective equipment into water and vinegar could be the game-changing solution the world needs to stop tonnes of PPE being dumped daily into landfills and oceans.

This miracle-sounding process has been developed at the University of Auckland's Faculty of Engineering.

Shredded masks, gowns, gloves and plastic safety glasses go into a machine; hot, pressurised water and compressed air are applied; water and acetic acid are the end-products.

The PPE-to-liquid process is carried out at a temperature of 300°C and takes about an hour in a small prototype machine in a laboratory in the faculty.

Gaseous by-products from the process are oxygen and low concentrations of carbon dioxide which can be safely discharged.

"This is a clean, chemical-free solution which will be a game changer internationally," says Dr Saied Baroutian, an associate professor in the faculty's Department of Chemical and Materials Engineering.

"The technology used is a hydrothermal deconstruction or valorisation process and it destroys the waste completely. The liquid produced in the process is safe, inert and can be reused – the vinegar or acetic acid can be used for disinfecting and the water can be reused for the processing cycle therefore minimising water consumption and helping with sustainability."

The process has been developed at the university in collaboration with the Faculty of Medical and Health Sciences and the Universities of Otago and Waterloo (Canada).

It is one of two innovative solutions that link up to tackle the Covid-19 healthcare waste problem which has been described as "threatening human and environmental health" by the World Health Organisation.

Dr Yvonne Anderson, a senior lecturer at the Department of Paediatrics, University of Auckland, is leading a project that uses revolutionary technology to disinfect PPE so it can be reused or recycled safely.

That project, a mobile solution that could be shipped to areas where there are PPE shortages, is detailed here.

"This is a clean, chemical-free solution which will be a game changer internationally," says Dr Saied Baroutian, an associate professor in the faculty's Department of Chemical and Materials Engineering.

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Says Dr Baroutian: "By developing two technologies – one for reusable waste and the other for waste that cannot be reused or recycled – we are closing the loop on this ever-growing serious waste issue and providing a circular solution that truly is clean and green.

The research teams are now taking steps to develop the solutions into a larger scale pilot system and, learning from that, will develop a full-scale proof-of-concept.

"That is the point where we can showcase the technology, ensure the designs will work with the flow of PPE waste and find funding or potential partnerships with commercial organisations so these technologies can be implemented in New Zealand and overseas," says Saeid.

In terms of cost, the researchers have already completed an economic analysis which shows a large-scale hydrothermal deconstruction system could process PPE waste at a cost comparable to the current practice of autoclaving and landfilling.

"And in terms of the environment," says Saeid, "the savings on offer are huge."

Funding for the project has been provided through a $1.3m grant from the Ministry of Business, Innovation and Employment (MBIE) through the Covid-19 Innovation Acceleration Fund, and a $46,000 grant from the Medical Assurance Society Foundation.

University of Auckland, 16 February 2022

https://auckland.ac.nz

How did doctors perform surgery before modern anesthesia?

2022-02-22

In 1811, English novelist Fanny Burney underwent a mastectomy without so much as a shot of whiskey to dim the pain. In letters she wrote to her sister after the operation, she recalls, "I began a scream that lasted unintermittingly [sic] during the whole time of the incision — and I almost marvel that it rings not in my ears still! So excruciating was the agony." In fact, Burney fainted twice from the pain of the incision, which likely came as a welcome relief.

Her operation took place during a time when surgical anesthesia was still in its infancy, and the limited options that existed could be unreliable and

As far back as the 1100s, there are accounts of physicians applying sponges soaked with opium and mandrake juice to patients to induce sleepiness.

often dangerous. Historical anecdotes like hers reveal "what a disgusting thing surgery was before anesthesia," said Tony Wildsmith, professor emeritus of anesthesia at the University of Dundee in Scotland, and former Royal Archivist at the Royal College of Anaesthetists in the United Kingdom.

Indeed, confronting such pain would be nightmarish. Today, anesthetics are now a fixture in medicine, comprising an array of drugs that are used not just for managing pain but also for relaxing muscles and making patients unconscious. Many people will, at some point in their lives, receive these drugs — whether it's a localized anesthetic to numb their gums at the dentist's office, an epidural during childbirth or a general anesthetic to induce a deep slumber while doctors remove tonsils.

But how did doctors do surgery before anesthetics? The answer reveals a cruder, more painful and occasionally suspect history.

Pain through the ages

Anesthesia as we know it today is a relatively new invention, but for centuries, we have been searching for ways to soothe severe pain. As far back as the 1100s, there are accounts of physicians applying sponges soaked with opium and mandrake juice to patients to induce sleepiness in preparation for an operation, and to dull the pain that followed.

Going back even further, manuscripts stretching from Roman to medieval times describe a recipe for a sedative mixture called "dwale." Made from a heady concoction of boar bile, opium, mandrake juice, hemlock and vinegar, the tincture was brewed "to make a man sleep whilst men cut him," according to one manuscript from the Middle Ages. From the 1600s onward in Europe, opium and laudanum (opium dissolved in alcohol) became common pain relievers.

But these medicines would have been crude, inexact and difficult to tailor to patients and their needs. What's more, they could be dangerous; hemlock can be fatal, for instance, and opium and laudanum are addictive. Mandrake in high doses can cause hallucinations, abnormal heart rate — and in extreme cases, death.

Against the backdrop of this unforgiving medicinal landscape, when surgeons did have to perform invasive surgeries, often the most sensible method they employed was simply to be as quick and precise as possible. "You go back 150-plus years, and surgery was brief," Wildsmith told Live

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Science. Efficiency and precision under time pressure became a measure of a surgeon's skill.

But speed and precision also confined surgeons to less-complex operations. For example, it's safe to assume that before the advent of surgical anesthesia in Europe and the United States in the mid-1800s, high-stakes surgeries such as cesarean sections and amputations in these regions would have been less common than they are today, both because of the skill and risks involved and the intense and unmanageable pain they would bring about, Wildsmith told Live Science. "There weren't many operations described, because there wasn't the ability to do them," he said.

In fact, dentistry was one of the few types of surgery that was comparatively more common during this period, because the pain and dangers involved in doing it were lower than in more serious types of surgery, Wildsmith explained. Needless to say, patients weren't exactly lining up to have these operations, either. "Try and put yourself in that position," Wildsmith said. "You've got pain, but the pain of having it relieved would be even worse."

Questionable methods

As surgeons sought new ways to do their work, some more unusual methods came about. One of these was compression, a technique that involved applying pressure to the arteries to render someone unconscious, or to the nerves to cause sudden numbness in the limbs.

The first technique possibly stretches back to ancient Greece, where physicians named the arteries in the neck the "carotids," a word with a Greek root meaning "to stun" or "stupefy." "So, there's evidence that they used it or knew that compression of the carotid arteries would produce unconsciousness," Wildsmith said. He emphasized, however, that there's no suggestion that this method was widely applied — and probably with good reason. Someone trying this extremely risky method today would be "more likely to end up in the dock for a charge of murder than anything else," Wildsmith said.

In 1784, a British surgeon named John Hunter tried compression of the nerves by applying a tourniquet to a patient's limb and causing numbness. Surprisingly, it worked: Hunter was able to amputate a limb, and apparently, the patient felt no pain, according to the Royal College of Anaesthetists.

Another pain management technique was 'mesmerism.' This pseudoscientific belief combined elements of hypnosis with theories that there was a force-field-like liquid in humans that could be manipulated with magnets, the Hektoen International Journal reported. The technique's inventor, Austrian physician Franz Anton Mesmer, believed that by controlling this malleable fluid, he could put patients in a state of suspended animation, during which they would be oblivious to the pain of surgery.

These pseudoscientific practices gained real traction. By the mid-1800s, mesmerism had spread to other parts of Europe and to India, and surgeons used it to operate on patients. And, in several instances, the patients were reportedly pain-free, according to a report in the Hektoen International Journal. Mesmerism became so popular, in fact, that several "mesmeric hospitals" were established in London and elsewhere.

But surgeons began to question these methods and accuse proponents of misleading the public. A rivalry ensued, and mesmerism was discredited. This set the stage for new and more promising candidates for pain relief and sedation: a series of inhalable gases that, by the mid-1800s, were poised to launch a new era of modern anesthesia, according to the Hektoen International Journal.

From pseudoscience to modern anesthesia

Leading up to the mid-1800s, scientists and surgeons grew increasingly interested in the clinical use of a sweet-smelling organic compound called ether, made by distilling ethanol with sulfuric acid. In fact, records of ether production go back as far as the 13th century, and in the 16th century, physicians experimenting with the mysterious substance discovered it could anesthetize chickens.

Several hundred years later, surgeons revisited ether in their work. "There were people scratching at the surface for a long time, "Wildsmith said. Finally, in 1846, an American dental surgeon named William Morton carried out a public operation in which he supplied gaseous ether to a patient and then painlessly removed a tumor from the patient's neck. It was the first clinical proof that the careful application of this gas could cause unconsciousness and ease pain.

Then, in 1848, surgeons proved that another compound, called chloroform, could successfully ease pain during childbirth and other surgeries. Critically, ether and chloroform gave surgeons more control over the condition of their patients, because by managing patient's pain

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and sending them to sleep, it bought surgeons more time to operate and therefore to do so more meticulously. Over time, this enabled more sophisticated surgeries. Neither of the two gases is used surgically anymore, but both ultimately laid the groundwork for the development of safer and more effective drugs that have turned anesthesia into the fine-tuned art it is today.

Wildsmith recalled an 18th-century oil painting that shows a man gaping in horror as he undergoes an amputation. "It genuinely depicts, by the look on the patient's face, what an awful exercise that must have been for a patient without anesthesia," Wildsmith said.

Anesthesia's history may be full of trial and error, but anyone who's ever set foot in a hospital can be grateful that at least it's taken us far from the nightmarish realities of that painting.

website, date

https://website

Do masks really harm kids? Here's what the science says.

2022-02-18

School mask mandates have become something of a political lightning rod in the United States during the COVID-19 pandemic—and, in recent weeks, the dominos have started to fall as one state after another has announced plans to lift their mandates.

Some parents and teachers have cited concerns that masks harm kids by impairing their ability to breathe, slowing their social and emotional development, and causing them anxiety. But experts say that the science doesn't back up those worries.

It's understandable why there might be confusion, says Thomas Murray, a pediatrician at the Yale University School of Medicine. There's no question that masking reduces the spread of disease, but the evidence is less cut and dry about how masking affects kids emotionally and developmentally over the age of two. To answer that definitively would require that researchers asking people to shed their masks for a randomized trial, the gold standard in science, which would be unethical. So, most masking research is based on retrospective real-life observations that can be more easily cherry-picked to argue one side or the other of the debate over mask mandates.

As more states drop mask mandates, experts explain why keeping them on in schools is still a smart move for families and teachers.

"But we do have this human experiment that's been going on with kids wearing masks at school, and we know that we haven't seen those fears of health risks realized," says Theresa Guilbert, a pediatric pulmonologist who is a member of the American Academy of Pediatrics Section on Pulmonary and Sleep Medicine.

She and other experts say most evidence suggests that masking doesn't harm children—and that it benefits them in more ways than one. Not only do masks protect kids from COVID-19 and other respiratory diseases, but studies show that schools with mask policies in place are more likely to stay open, which decades of research show is particularly critical for kids' mental health and development.

Here's what the science says about kids and masks.

How masks affect breathing

One of the earliest concerns that parents had about kids wearing masks all day was how it might affect their breathing—whether masks would allow them to get enough oxygen or trap in too much carbon dioxide. Guilbert says this was raised as a concern for kids since they breathe more rapidly than adults.

But there's no evidence that masking significantly impairs breathing. In fact, one study showing unacceptable levels of carbon dioxide in kids ages six to 17 who wore masks was widely discredited last summer—and ultimately retracted by the journal JAMA Pediatrics—because of concerns over the accuracy of its measurements and validity of its conclusions.

Instead, Guilbert points to a meta-analysis of 10 studies, showing that the fluctuation of carbon dioxide and oxygen levels among adults and children wearing masks was "well within normal range." While children with severe asthma might need to take mask breaks in the hallway outside of the classroom, these studies show that most kids can tolerate them.

She points out that this makes sense based on what we know about the size of carbon dioxide and oxygen molecules—which are far smaller than the holes in the weave of cloth and surgical masks and should have no trouble flowing in and around the masks. Moreover, she says, two years into the pandemic, hospitals just aren't seeing an influx of children with dangerously low oxygen or high carbon dioxide levels due to masking.

"There's a lot of hypotheses thrown around, but we have this real-life experiment going on," she says.

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How masks affect language development

Another concern has been whether masks might impede children's language development. Samantha Mitsven, a psychology doctoral candidate at the University of Miami, says she and other researchers worried that the inability to see a speaker's mouth move—and the muffling effects of wearing a mask—could keep children from understanding and learning new words.

Studies have shown that masks muffle sound—and how significantly varies depending on the type of mask. One study showed that children can more easily recognize words spoken through opaque masks rather than transparent masks, likely due to the confusion caused by light bouncing off a transparent mask. Another study suggests that surgical masks offer the best acoustical performance, followed by KN95 and N95 masks, then cloth masks—with transparent masks again coming in last.

But experts say there's no clear evidence that this significantly impairs a child's ability to communicate—perhaps because people can compensate by talking more slowly and loudly and by using hand gestures to convey meaning.

Mitsven led a recent study analyzing audio recordings of preschoolers—one classroom that was observed over multiple visits before the pandemic and another classroom that was observed when the children and teachers were required to mask. The study found no difference in how much the children spoke or the diversity of the language they used. This was true even for children with hearing aids and cochlear implants, a population that made up half of each class.

"The vocalizations are on par with children their age," Mitsven says.

How masks affect social development

Similarly, studies do show that children have a harder time reading the emotions of people who are wearing masks—but that doesn't necessarily prevent them from learning how to interact with others.

From the earliest months of life, children watch the faces of the people around them. This helps them first distinguish between positive and negative emotions and ultimately learn how to adjust their behavior accordingly.

Covering up the bottom half of one's face with a mask does affect that ability: A study published in Frontiers in Psychology showed that children

between the ages of three and five were less adept at recognizing the emotions on photographs of people wearing masks compared to photographs of unmasked people.

But Walter Gilliam, a child psychiatry and psychology professor at the Yale Child Study Center, says this study and others like it are limited by their reliance on still photographs. "I'm more than just my eyeballs," he says. Children also pick up on cues like how people walk through spaces, the tone of their voices, and the hand gestures they make. "All of that is stripped away from those studies." He points to another study showing that children have no more difficulty reading the emotions of a person wearing a face mask than they do a person wearing sunglasses.

These studies are also only a snapshot in time—they can't tell us how quickly children would be able to adapt to these challenges if given the chance. "Everything I know about child development would tell me that they'd adjust quickly," Gilliam says. "I wish that we had more faith in the capacity of children."

Guilbert agrees that there's no sign that masking keeps children and adolescents from developing socially—and, she argues, it might be key to ensuring they can go to school. Over the course of two years, evidence has grown that masking policies help schools stay open by reducing the number of outbreaks.

How masks affect mental health

Similarly, while some argue that school masking mandates are harmful to a child's mental health, experts say the evidence suggests the opposite. Guilbert says the most significant signal of the pandemic's toll on mental health came early in the pandemic. Back then children who were doing remote learning experienced increased levels of anxiety and depression because they weren't at school with their peers.

Gilliam and Murray, the Yale researchers, were also concerned about how school shutdowns were affecting the mental health of kids and their stressed-out parents alike. With that in mind, they decided early in the pandemic to investigate the most effective strategies for keeping schools and early childcare programs open.

In May 2020, the researchers surveyed 6,654 childcare professionals in all 50 U.S. states to find out which COVID-19 mitigation tactics they were using, including social distancing, symptom screening, and masking. Then, a year later, they followed up to see if those programs had been forced

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to close. Their resulting analysis shows that childcare facilities with mask requirements for kids older than two were 13 percent more likely to have remained open than those where kids were not masked.

As with many of the other studies on masking in schools, Gilliam and Murray concede that their study is limited: It's based on real-world observations and could not control for other factors—like, say, whether the adults and children who masked also avoided travel throughout the same period. But it still provides more compelling evidence that masking policies have more potential to help rather than hurt a child's mental health.

"We can't wear masks forever, but you can't have kids missing 10 days of school every so often because of quarantine," Murray says.

Gilliam says blaming masks for the depression and anxiety in kids stems from a natural desire to protect them. But he suspects it's not the masking that causes stress in classrooms. "It's the trauma of COVID that the masks were intended to prevent," he says. "When you have an ache and a pain, it's the cut on your arm not the Band-Aid that went over it that's causing the problem. The purpose of the mask is to reduce all the other traumas—traumas that we know for an absolute fact harm children."

How will we know when to drop mask mandates?

So how can science help guide schools in making these decisions? Well, for one, experts caution that it's important for policymakers to keep in mind that there are always outliers in a study. So even though the evidence suggests that masking doesn't harm most children, mask mandates may need to carve out exemptions for children who are deaf and need to read lips or for children with autism who struggle to interpret facial expressions.

Murray says that risk mitigation is also best done in layers—and that schools have an array of tactics they can use against COVID-19. To prevent the virus from getting into schools in the first place, they can implement robust testing and symptom-checking strategies. But if the disease is there and spreading among students, masking and ventilation become more important mitigation strategies. So, if schools are going to remove masking policies, he says, they need to think about stepping up ventilation or testing.

Community transmission matters, too. Rochelle Walensky, director of the U.S. Centers for Disease Control and Prevention, has urged lawmakers not to drop school mask mandates while infections remain high across the

country. Although case numbers are falling, they remain higher than they were before the Omicron surge.

While lifting mask mandates might make sense during times when local cases are low, Murray says that schools need to be willing to go back to masking if a harmful new variant emerges or if they start to see a new surge in cases. There's no magic number to determine when to lift mandates, he says—it can differ based on a variety of factors that can mitigate transmission, such as whether schools have enough space for students to spread out or whether it's warm enough to open classroom windows. But Murray argues that it's important to be willing to consider the evidence and be willing to change your mind when more evidence comes available.

"The point is," he says, "I agree that at some point we have to try it, but boy you've got to have a really thoughtful plan because having kids out of early childcare and parents scrambling to find alternative safe care is not good for anybody."

National Geographic, 18 February 2022

https://nationalgeographic.com

Are Microbes the Future of Recycling? It's Complicated.

2022-02-23

SINCE THE FIRST factories began manufacturing polyester from petroleum in the 1950s, humans have produced an estimated 9.1 billion tons of plastic. Of the waste generated from that plastic, less than a tenth of that has been recycled, researchers estimate. About 12 percent has been incinerated, releasing dioxins and other carcinogens into the air. Most of the rest, a mass equivalent to about 35 million blue whales, has accumulated in landfills and in the natural environment. Plastic inhabits the oceans, building up in the guts of seagulls and great white sharks. It rains down, in tiny flecks, on cities and national parks. According to some research, from production to disposal, it is responsible for more greenhouse gas emissions than the aviation industry.

This pollution problem is made worse, experts say, by the fact that even the small share of plastic that does get recycled is destined to end up, sooner or later, in the trash heap. Conventional, thermomechanical recycling — in which old containers are ground into flakes, washed, melted down, and then reformed into new products — inevitably yields products that are more brittle, and less durable, than the starting material. At best, material from a plastic bottle might be recycled this way about three times before it becomes unusable. More likely, it will be "downcycled" into lower value materials like clothing and carpeting—materials that will eventually be disposed of in landfills.

Conventional, thermo-mechanical recycling — in which old containers are ground into flakes, washed, melted down, and then reformed into new products — inevitably yields products that are more brittle, and less durable, than the starting material.

"Thermomechanical recycling is not recycling," said Alain Marty, chief science officer at Carbios, a French company that is developing alternatives to conventional recycling.

"At the end," he added, "you have exactly the same quantity of plastic waste."

Carbios is among a contingent of startups that are attempting to commercialize a type of chemical recycling known as depolymerization, which breaks down polymers — the chain-like molecules that make up a plastic — into their fundamental molecular building blocks, called monomers. Those monomers can then be reassembled into polymers that are, in terms of their physical properties, as good as new. In theory, proponents say, a single plastic bottle could be recycled this way until the end of time.

But some experts caution that depolymerization and other forms of chemical recycling may face many of the same issues that already plague the recycling industry, including competition from cheap virgin plastics made from petroleum feedstocks. They say that to curb the tide of plastic flooding landfills and the oceans, what's most needed is not new recycling technologies but stronger regulations on plastic producers — and stronger incentives to make use of the recycling technologies that already exist.

Buoyed by potentially lucrative corporate partnerships and tightening European restrictions on plastic producers, however, Carbios is pressing forward with its vision of a circular plastic economy — one that does not require the extraction of petroleum to make new plastics. Underlying the company's approach is a technology that remains unconventional in the realm of recycling: genetically modified enzymes.

ENZYMES CATALYZE chemical reactions inside organisms. In the human body, for example, enzymes can convert starches into sugars and proteins into amino acids. For the past several years, Carbios has been refining a method that uses an enzyme found in a microorganism to convert polyethylene terephthalate (PET), a common ingredient in textiles and plastic bottles, into its constituent monomers, terephthalic acid, and mono ethylene glycol.

Although scientists have known about the existence of plastic-eating enzymes for years — and Marty says Carbios has been working on enzymatic recycling technology since its founding in 2011 — a discovery made six years ago outside a bottle-recycling factory in Sakai, Japan helped to energize the field. There, a group led by researchers at the Kyoto Institute of Technology and Keio University found a single bacterial species, Ideonella sakaiensis, that could both break down PET and use it for food. The microbe harbored a pair of enzymes that, together, could cleave the molecular bonds that hold together PET. In the wake of the discovery, other research groups identified other enzymes capable of performing the same feat.

Enzymatic recycling's promise isn't limited to PET; the approach can potentially be applied to other plastics, including polyurethane, used in in foam, insulation, and paint. But PET offers perhaps the most expansive commercial opportunity: It is one of the largest categories of plastics produced, widely used in food packaging and fabrics. PET-based beverage bottles are among the easiest plastics to collect and recycle into a marketable product.

Traditional depolymerization technologies rely on inorganic catalysts rather than enzymes. But some chemical recycling companies have struggled in efforts to turn PET recycling into a viable business model — with some even facing legal scrutiny.

Despite this, Marty says that Carbios' enzyme-based approach offers advantages over traditional depolymerization methods: The enzymes are more chemically selective than synthetic catalysts — they can more precisely target specific sites on specific molecules — and could therefore yield purer product. Plus they work at relatively low reactor temperatures and do not require expensive, hazardous solvents.

Traditionally, however, the problem with enzymes has been that they work slowly and can destabilize under heat. In early experiments, it sometimes took weeks to process just a fraction of a batch of PET. In 2020, Marty and colleagues at Carbios, along with researchers in France, announced that they had engineered an enzyme — a so-called cutinase, naturally found in microbes that decompose leaves — that could withstand warmer temperatures and convert nearly an entire batch of PET into monomers in a matter of hours. The discovery dramatically boosted enzymatic recycling's commercial prospects; In the 10 months that followed, Carbios' stock price on the Euronext Paris exchange grew about eightfold.

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Last September, Carbios began testing its technology at a demonstration facility near its headquarters in Clermont-Ferrand, France, about a two-hour drive west of Lyon. Used PET arrives here as thin, pre-processed flakes about one-fifth of an inch across. In a 16-foot-tall reactor, the flakes are mixed with the patented cutinase enzymes —produced by Denmark-based biotechnology company Novozymes — and warmed to a little above 140 degrees Fahrenheit. Within 10 hours, Marty says, 95 percent of the plastic fed to the reactor, the equivalent of 100,000 plastic bottles, can be converted into monomers, which are then filtered, purified, and prepared for use in plastic manufacturing. (The remaining 5 percent, made up of unreacted plastic and impurities, is incinerated.) As Marty describes it, the end product is physically indistinguishable from the petrochemical-based substances used to manufacture virgin PET.

CARBIOS' RECYCLING TECHNOLOGY has grabbed the attention of some of the world's largest consumer goods companies. L'Oréal, Nestlé, and PepsiCo have collaborated with the startup to produce proof-of-concept bottles, and all seem intent on eventually putting enzyme-recycled plastic on shelves.

But Kate Bailey, the policy and research director at Eco-Cycle, a nonprofit recycler based in Colorado, says that over her 20 years in the recycling industry, she has grown skeptical of biotechnology fixes like the one being touted by Carbios. While she acknowledges that new solutions are needed, given the urgency of the plastic problem, she says "we don't have more years to figure this out and wait for new technology." Bailey points to lingering questions about how enzymatic recycling will be scaled up to handle commercial volumes, including questions about its energy footprint and its handling of toxic chemical additives found in many consumer plastics.

Marty concedes that Carbios' process is, indeed, more energy-intensive than conventional recycling — he declined to specify by how much — but added that it's not fair to compare enzymatic recycling with thermomechanical processes, which don't produce as high quality of a recycled product and eventually result in the same quantity of waste. Still, he said, it requires less energy, and releases less greenhouse gas, than producing virgin PET from petroleum — claims that are supported by an independent analysis published last year by the U.S. National Renewable Energy Laboratory. As for additives, he says they are filtered out during post-reaction processing and incinerated.

But the most stubborn hurdle for Carbios and other enzymatic recycling hopefuls may be an economic one. "It's super cheap to make virgin plastic, especially with the low price of oil," said Bailey.

"You have to be able to sell your recycled PET against to some company that also has the option of buying virgin PET," she added, "and when virgin is just cheaper, then that's what companies buy."

In its analysis, the National Renewable Energy Laboratory estimated that PET monomers produced through enzymatic recycling would carry a price of at least $1.93 per kilogram; virgin, petroleum-based monomers have ranged between $0.90 and $1.50 per kilogram since 2010. And now that many fossil fuel companies are pivoting their business models toward plastic production, the market competition for plastic recyclers could grow even stiffer.

Marty, however, is optimistic about his company's prospects. He points out that the price of oil is rising and that tightening regulations on the use of fossil fuels in Europe is making recycled plastic more competitive there. Several consumer goods giants have publicly committed to sourcing more of their products from recycled materials: Coca-Cola pledged to use recycled material for half of its packaging by 2030, and Unilever aims to cut its reliance on virgin plastic in half by 2025.

"At the beginning, sure, it will be a little more costly," Marty said. "But we will reduce, with experience, the cost of this recycled PET."

WOLFGANG STREIT, a microbiologist at the University of Hamburg, says that even if companies achieve commercial success with PET, some polymers may never be amenable to the enzymatic recycling. Polymers like polyvinylchloride, used in PVC pipes, and polystyrene, used in Styrofoam, are held together by powerful carbon-carbon bonds, which might be too sturdy for enzymes to overcome, he explains.

That's one reason Bailey believes new policies need to be considered alongside new technologies in addressing the global plastic waste problem. She advocates for measures that limit the production of hard-to-recycle plastics and improve collection rates for materials like PET, which can be recycled, albeit imperfectly, with existing technologies. Bailey notes that currently only about three in 10 PET bottles gets collected for recycling. She describes that as low-hanging fruit "that we could solve today with proven technology and policies."

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Now that many fossil fuel companies are pivoting their business models toward plastic production, the market competition for plastic recyclers could grow even stiffer.

Most PET produced globally is used not for bottles but for textile fibers, which, because they often contain blended materials, are rarely recycled at all. Mats Linder, the head of the consulting arm of Stena Recycling in Sweden, said he'd like to see chemical recycling technologies focus on these and other parts of the recycling industry where conventional recycling is coming up short.

As it happens, Carbios is working to do just that, Marty says. The French company Michelin has validated the company's technology, which could allow it to recycle used textiles and bottles into tire fibers. It aims to launch a textile recycling operation in 2023, and Marty says the company is on track to launch a 44,000-ton-capacity industrial scale facility in 2025.

Gregg Beckham, a senior research fellow at the National Renewable Energy Laboratory, believes the global plastic problem will call for a diverse mix of technological and policy solutions, but he says enzymatic recycling and other chemical recycling technologies are advancing rapidly, and he's optimistic that they will have a role to play. "I think chemical recycling is useful in the contexts where other solutions don't work," he said. "And there are many places where other solutions don't work."

Undark, 23 February 2022

https://undark.org

Limitless power arriving too late: why fusion won't help us decarbonise

2022-02-25

I first heard the standard joke about fusion as an undergraduate physics student in the 1960s: Fusion power is fifty years away – and probably always will be.

More than fifty years later, we still don't have fusion. That's because of the huge experimental challenges in recreating a miniature sun on earth.

Still, real progress is being made. This month, UK fusion researchers managed to double previous records of producing energy. Last year, American scientists came close to ignition, the tantalising moment where fusion puts more energy out than it needs to start the reaction. And

I first heard the standard joke about fusion as an undergraduate physics student in the 1960s: Fusion power is fifty years away – and probably always will be.

small, fast-moving fusion startups are making progress using different techniques.

A limitless, clean source of baseload power might be within reach – without the nuclear waste of traditional fission nuclear plants. That's good, right?

Not quite. While we're closer than ever to making commercial fusion viable, this new power source simply won't get here in time to do the heavy lifting of decarbonisation.

We are racing the clock to limit damage from climate change. Luckily, we already have the technologies we need to decarbonise.

How much progress is being made on fusion?

Five seconds. That's how long the UK's Joint European Torus was able to sustain a fusion reaction, producing enough energy to run a typical Australian household for about three days. That's a small fraction of the energy needed to make the fusion reaction happen, which used two 500 megawatt flywheels. That amount of power would meet the peak needs of 100,000 average Australian households. So we are still a long way from getting a net energy benefit from fusion.

On a technical front, achievements like this are incredible. Nuclear fusion is the process that powers stars like the sun, and we are working to harness this for our own use.

At very high temperatures, light atoms such as hydrogen can combine to produce another element such as helium, releasing enormous quantities of energy in the process.

In the sun, these fusion reactions take place at temperatures about 10 million degrees. We can't do it at that temperature, because we don't have access to the enormous gravitational pressure at the centre of the sun.

To achieve fusion on earth, we need to go hotter. Much hotter. Experiments like the one in the UK are able to superheat a body of gas called a plasma to inconceivable temperatures, reaching as high as 150 million . The plasma has to be confined by incredibly strong magnetic fields and heated by powerful lasers.

This temperature is far hotter than anywhere else in our solar system – even the centre of the sun.

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While the recent progress represents a major step forward, sober reflection suggests the dream of limitless clean energy from hydrogen is still a long way off.

On the megaproject front, the next step is the International Thermonuclear Experimental Reactor (ITER) being built in southern France. Far too big for any one country, this is a joint effort by countries including USA, Russia, China, the UK and EU member countries.

The project is enormous, with a vessel ten times the size of the UK reactor and around 5,000 technical experts, scientists and engineers working on it. Famously, the project's largest magnet is strong enough to lift an aircraft carrier.

Even this enormous project is only expected to produce slightly more power than it uses - around 500 megawatts. The first experiments are expected by 2025.

To me, this illustrates how far away commercial fusion really is.

Fusion won't get here in time

It will take decades yet to go from these promising experiments to a proven technology powering modern society. That means it simply will not get here in time to make a real contribution to slowing and reversing climate change.

To have a decent chance of keeping climate change below 2 , we have to get to net zero emissions worldwide in under 30 years.

We can't wait. We have to decarbonise energy supply and energy use as quickly as possible.

Many countries are already moving at speed. The UK is planning to get to zero-emissions electricity within 12 years. States like South Australia and New South Wales should get there around the same time. The International Energy Agency predicts renewables will become the largest source of electricity generation worldwide by 2025.

The shift away from baseload

Even if fusion arrives, it would face major challenges due to the cost of the plants and the changing nature of the grid.

In the second half of the twentieth century, power stations became larger to achieve economies of scale. That worked, until recently. Only ten

years ago, large coal-fired or nuclear power stations produced cheaper electricity than solar farms or wind turbines.

This picture has changed dramatically. In 2020, global average prices of power from new large wind turbines was 4.1 cents per kilowatt-hour, while solar farms were even cheaper at 3.7 c/kWh. The average for new coal? 11.2 c/kWh.

Ever more favourable economics drove a massive investment in renewables in 2020: 127 gigawatts of new solar, 111 of new wind and 20 of hydro-power. By contrast, only 3GW of net nuclear power came online, while coal-fired power actually dropped.

As a result, we're seeing a global shift away from old models of baseload power, where power is generated in large power stations and transported to us by the grid.

These shifts are driven by cost. The price of electricity from renewables is now falling below the running costs of old coal-fired or nuclear power stations. Coal power requires digging the stuff up, transporting it, and burning it. Renewables get their power source delivered free of charge.

The idea of fusion power is alluring. There's a real appeal in the idea we could replace large coal and gas stations with one large clean fusion power plant. That, after all, is the selling point of the International Thermonuclear Experimental Reactor: to produce baseload power.

But will we need it? The pattern of power supply is changing. The massive take-up of solar power by households means we have now permanently shifted from the old model of large power stations to one where supply is distributed around the network.

It will be a technological marvel if we are finally able to build fusion plants in the second half of this century. It's just that they won't be in time.

Luckily for us, we don't need fusion. We already have what we need.

The Conversation, 25 February 2022

https://theconversation.com

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How are proteins sorted in the cell? Research team solves this decade-old puzzle

2022-02-24

Researchers solve the more than 25-year-old puzzle of how proteins are sorted in the cell. A protein complex known as NAC (nascent polypeptide-associated complex) serves as a "gatekeeper" in protein synthesis, regulating the transport of proteins within the cell. The molecular mechanism behind this function has now been elucidated by cell and molecular biologists from Konstanz within an international collaborative project.

For the maintenance of our cellular functions, it is essential that proteins are transported to various destinations within the cell—referred to as "cell organelles" in analogy to the organs of our body—while they are still being synthesized. But how is it possible to distinguish between different transport destinations and prevent proteins from reaching the wrong organelles? An international research team has now discovered how this complex process is controlled at the molecular level for an important cellular destination—the transport of nascent proteins to a membrane network of the cell, the endoplasmic reticulum.

In their current publication in the journal Science, the researchers were able to show that a protein complex known among experts as NAC, which was discovered more than 25 years ago, plays a decisive role in this process: Like a gatekeeper, NAC ensures that only proteins with the endoplasmic reticulum as destination are passed on to the protein transporter SRP (signal recognition particle). SRP then mediates the transport of the "cargo" to the specified destination. If, on the other hand, a nascent protein has a destination other than the endoplasmic reticulum, the gatekeeper NAC denies access to the protein transporter SRP.

Protein factory

Using the genetic material as a blueprint, thousands and thousands of new proteins are produced every minute in the cells of our body. This protein production takes place in the ribosomes, the cellular "factories" of our bodies, where individual amino acids—the building blocks of proteins—are assembled into long amino acid chains. The resulting proteins can later take on a wide variety of functions and accordingly have different destinations within the cell. Suitable sorting mechanisms therefore often already ensure during protein production that the proteins reliably reach their respective location within the cell.

The molecular mechanism behind [NAC protein gatekeeping] has now been elucidated by cell and molecular biologists from Konstanz within an international collaborative project.

Until now, it was known that two protein complexes, the aforementioned NAC and SRP, play an important role in the targeted transport of nascent proteins to the endoplasmic reticulum. SRP is the actual "transport protein" that establishes the contact of the nascent proteins together with the ribosome to the endoplasmic reticulum. It recognizes a specific transport signal that is encoded in the newly synthesized protein. However, there is a problem: SRP also binds non-specifically to ribosomes that have no signal for the endoplasmic reticulum.

"Uncontrolled, SRP would bind to any ribosome close by and then transport it to the endoplasmic reticulum, regardless of whether or not a protein with that destination is currently being produced. This would result in countless misdeliveries that would severely impair the function and viability of the cell," explains Elke Deuerling, one of the senior authors of the current study and professor of molecular microbiology at the University of Konstanz. So the researchers conclude that there is a control instance that prevents exactly that: the gatekeeper NAC.

Tracking down the molecular mechanism

How exactly NAC prevents SRP from binding non-specifically to any ribosome at the molecular level and instead ensures that only the correct ribosomes are transported to the endoplasmic reticulum was previously unclear. The biologists from Konstanz investigated this question in their current study in collaboration with colleagues from ETH Zurich (Switzerland), MRC Laboratory of Molecular Biology (LMB, Cambridge, UK) and the California Institutes of Technology (Caltech, Pasadena, U.S.).

To do this, they first simulated the processes in the cell by mixing purified ribosomes together with NAC and SRP in the test tube. The mixture was then snap-frozen at below -150 degrees Celsius and the sample examined under an electron microscope—a method known as cryoelectron microscopy. This allowed structural biologists Dr. Ahmad Jomaa and Dr. Viswanathan Chandrasekaran, co-authors of the study, to reveal how NAC binds to ribosomes before and after cargo transfer to SRP. This was an important cornerstone in elucidating the gatekeeper mechanism, but the transition between the states remained unclear.

"The transition is a highly dynamic process that cannot be visualized by cryoelectron microscopy," explains Dr. Martin Gamerdinger, one of the lead authors from the University of Konstanz. To understand this process, he and his team, doctoral researchers Annalena Wallisch and Zeynel Ulusoy, conducted high-resolution biochemical binding studies that revealed in

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detail the interaction mechanism of NAC on ribosomes depending on the type of protein synthesized.

NAC as a gatekeeper

Using this method and computer-assisted reconstruction of the 3D structures, as well as experiments by Dr. Hao-Hsuan Hsieh on the binding strength between the components involved, the researchers succeeded in deciphering how NAC works at the molecular level. Based on their results, they were able to suggest a detailed molecular mechanism for NAC's sorting function.

According to this, NAC binds to the ribosome, specifically to the section where the nascent protein leaves the "protein factory." Like a gatekeeper, part of NAC sits protectively in front of this exit, the ribosomal tunnel, and denies SRP access to the ribosome and the nascent protein. Access is only granted when a transport signal sequence for the endoplasmic reticulum—encoded in the nascent protein—leaves the tunnel in the course of the protein synthesis. NAC recognizes this signal and changes its position on the ribosome. This way, the exit of the ribosomal tunnel becomes unblocked and SRP can now dock to the tunnel exit after being actively recruited to the ribosome via a "grabbing arm" of NAC, i.e. the UBA domain. After SRP binding and signal sequence transfer, the ribosome together with the nascent protein is transported to the endoplasmic reticulum.

"Our study reveals the molecular function of NAC as a gatekeeper, granting SRP only access for those nascent proteins whose destination is the endoplasmic reticulum," Professor Elke Deuerling summarizes this fundamental control mechanism. She agrees with her international cooperation partners Professor Nenad Ban (ETH Zurich, Switzerland), Professor Shu-ou Shan (Caltech, U.S.) and Professor Ramanujan Hegde (MRC-LMB, UK): "Future studies will have to show whether NAC also has other control functions at the ribosomal tunnel."

Phys Org, 24 February 2022

https://phys.org

How squid camouflage could help prevent skin cancer in humans

2022-02-24

It wasn't the result the scientists wanted.

"When we noticed it changed color in light, we were super annoyed," says Leila Deravi, assistant professor of chemistry and chemical biology at Northeastern. That meant the substance wasn't stable enough for the applications Deravi had in mind.

But the disappointment was short-lived, as Dan Wilson, a research scientist at Northeastern's Kostas Research Institute, quickly realized that the outcome could be turned into a feature rather than a bug.

Wilson built on the unwanted chemical reaction to create dime-sized devices that change color when they've been exposed to a damaging amount of ultraviolet radiation, helping people prevent cancer-causing skin damage. The invention is essentially a tiny sticker that people could place on a shirt, hat, or bathing suit when they're headed outside.

"We all know more or less that too much sun on a high-UV-index day is bad. But we don't necessarily know how that translates to time in the sun," Wilson says. "This is meant to provide a visual, qualitative indication of when you may have been in the sun for too long and you should consider spending some time in the shade or reapplying your sunscreen."

The development of this device started not with humans, but with squid.

At the time, Wilson was a postdoctoral research associate in Deravi's Biomaterials Design Group. The team studies how cephalopods—tentacled sea creatures such as octopus, squid, and cuttlefish—camouflage themselves to blend into their environment. With a particular focus on squid, the researchers have identified and isolated many mechanisms, pigments, and chemical reactions that enable the animals to alter their appearances with ease.

When the circuitous discovery occurred, Wilson was testing one substance critical to squid's color-changing capabilities: a pigment called xanthommatin. The small molecule gives squid skin its visible color.

Deravi's team had already found that xanthommatin could be manipulated to change color, and she hoped that it might be something that could be integrated into materials for a variety of applications such as apparel, or other consumer products. But in order for that to be possible, she says, xanthommatin would need to be stable and controllable in many environments.

So when Wilson noticed that xanthommatin would change color when left out on the lab bench in ambient natural light, Deravi was initially disappointed.

"When we noticed it changed color in light, we were super annoyed," [...] That meant the substance wasn't stable enough for the applications Deravi had in mind.

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But Wilson saw this revelation as an opportunity. If the substance reacts to the ultraviolet radiation that is sunlight, then it could be used as a sensor for exactly that. And he had just the method in mind.

In graduate school, Wilson studied paper-based microfluidics. He leveraged that knowledge to build a system that dyes tiny pieces of paper with the xanthommatin pigment and activates it with the press of a button.

The wearable device is about the size of the tip of one of Wilson's fingers. It's made of five thin layers of carefully crafted sheets of plastic, and a round piece of paper that has been treated with the pigment and dried out. The sensor is activated when a user presses on the "button," a small reservoir of fluid in the edge of the device. That pressure pushes the fluid through channels cut into a middle layer of plastic in order to hydrate the treated paper. Once it's wet, it will react under UV radiation, changing from a yellow/orange color to a red the more it has been exposed.

The plastic itself is mostly made of the same material used for a transparent sheet for an overhead projector. There's a simple base layer, then the channel layer, topped with a layer to seal off all of the channels except for a small hole at the middle out of which the fluid flows. The fourth layer is a spacer, with a wide hole cut into it into which Wilson carefully places the paper sensor using long, thin tweezers. The sensor layer is topped with a thin film of plastic typically used in the walls or roof of a greenhouse. Wilson selected this material because it lets through as much sunlight as possible.

Wilson tested the device under many conditions, described in a paper published this month in the journal ACS Sensors, and calibrated it for UV levels that people are likely to experience in a range of natural conditions.

"I think you're always surprised by what a safe sun time is," he says. "It really depends on the weather, but it can be minutes."

Sunscreen, however, helps. Wilson tried coating the sensor with sunscreen and found that the color-change happened much more slowly. Users could put sunscreen on the device when they apply sunscreen to their own skin as a way to match their application with the sensor's alert, he says.

The researchers expect that people will use this device to monitor sun exposure, but the sensor also could be used in other situations where there's utility to measuring light exposure. For example, UV radiation is

often used to sterilize environments. Deravi says these stickers could be used to indicate when a surface has been exposed to UV radiation for long enough to be fully sterilized.

Phys Org, 24 February 2022

https://phys.org

Fight or flight? How birds are helping to reveal the mysteries of evolution

2022-02-24

New research from the University of Massachusetts Amherst uncovers the negative link between flightworthiness and fight-worthiness in birds. Evolutionary pressure demanded that birds could either fly or arm themselves—but not both. Furthermore, the new research suggests that developing wings and not bony spurs involved both sexual and natural selection. This insight helps us better understand how the enormous diversity of life and earth came to be.

Beetles do it, deer do it, even crabs in the sea do it. But birds don't. Carry weapons that is. "It's kind of puzzling," says João C. T. Menezes, graduate student in the Organismic and Evolutionary Biology Program at UMass Amherst and lead author of the new paper, published recently in Ecology Letters. "Birds have such spectacular songs, plumage and dances, but they mostly don't have specialized weapons. It's strange because dancing, singing, fancy feathers and fighting are all ways of successfully obtaining a mate, and often go together."

To understand why, Menezes and his co-author, Alexandre V. Palaoro of Clemson University, went searching for two things: a dependable estimate of how many species of birds do in fact carry weapons, and a way of measuring how much, and how well, different species fly.

It turns out that, although the vast majority of birds are unarmed, a small percentage, 1.7% do pack weapons in the form of bony spurs on their legs. To measure different species' flight aptitude, the researchers relied on the hand-wing index, or HWI, an enormous dataset that evaluates more than 10,000 species of birds and which lets researchers compare how efficiently different birds are at taking wing.

Menezes and his coauthor then compared the two sets of data and found a striking correlation: "the best fliers tend to lack spurs," says Menezes, "and

Beetles do it, deer do it, even crabs in the sea do it. But birds don't. Carry weapons that is.

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the most heavily armed fighters tend to struggle in the air." All of which immediately begged the question, why?

To answer that, the researchers ran a number of simulations and models, which showed that bony spurs could impose a heavy evolutionary cost. While it's true that weapons, like plumage, dancing and the ability to sing helps attract a mate and so are an advantage in sexual selection, the spurs make flying a more energy-intensive activity. Though it's remarkably difficult to pin down exactly how this affected the course of evolution, it seems likely that spurs decreased an individual's ability to fly fast, far and takeoff easily. This is where natural selection should kick in: spurs might make birds more likely to get eaten or require more food to meet their daily energy requirements, while their unspurred counterparts can get away, eat less and live to breed another day.

"This helps explain why birds have an amazing range of plumage, song and dance, while almost totally lacking in the weaponry department," says Menezes.

Phys Org, 24 February 2022

https://phys.org

How to mix the 'un-mixable'

2022-02-24

In one of the grand challenges of science, a Flinders University device which previously 'unboiled' egg protein is now unravelling the mystery of incompatible fluids; a development that could enhance many future products, industrial processes and even the food we eat.

Using the highly advanced rapid fluidic flow techniques possible in the Flinders vortex fluidic device (VFD), the Australian research team has capped off 10 years of research to find a way to use clean chemistry to unlock the mystery of 'mixing immiscibles'.

This will have applications in a range of global industries -- from food processing and nutraceuticals to cosmetics and drug delivery (think more pure and effective fish oil capsules), says Flinders University Professor Colin Raston, senior author in a new paper, published today in Chemical Science.

"Mixing immiscible liquids is fundamentally important in process engineering and usually involves a lot of energy input and waste products," says Professor Raston, 2020 SA Scientist of the Year.

Imagine making some liquids mix that do not mix, then unmixing them.

"We now demonstrate how this process, using a common solvent and water, can avoid the use of other substance for controlling reactions across immiscible liquids, making it cleaner and greener" says Professor in Clean Technology.

"Using thin-film microfluidics in combination with high shear flow chemistry and high heat and mass transfer, the rapidly evolving VFD technology is overcoming the mixing limitations of traditional batch processing," says co-author Matt Jellicoe, also from the Flinders Institute for Nanoscale Science and Technology.

"We conducted over 100,000 experiments to establish how liquids mix and what their flow behaviours are at very small nano-meter dimensions," adds co-author Aghil Igder, also from the Flinders Institute for Nanoscale Science and Technology.

As well, the Flinders University team has also upsized the VFD machine on experimental biodegradable polymers to start making its organic substances and clean technologies available at scale to suit a range of industries.

The VFD has been used in multiple experiments to produce quality drug elements such as peptides, better fish oil and food products and many other value-adding green chemical processes which can now be replicated in a scaled-up version of the device which has been developed.

'Vortex fluidic induced mass transfer across immiscible phases' (2022) by Matt Jellicoe, Aghil Igder, Clarence Chuah, Darryl B Jones, Xuan Luo, Keith A Stubbs, Emily M Crawley, Scott J Pye, Nikita Joseph, Kasturi Vimalananthan, Zoe Gardner, David P Harvey, Xianjue Chen, Filomena Salvemini, Shan He, Wei Zhang, Justin M Chalker, Jamie S Quinton, Youhong Tang and Colin L Raston has been published in Chemical Science (Royal Society of Chemistry).

Collaborators in the project include researchers from Guangzhou University in China, The University of WA, University of Newcastle, ANSTO and Flinders Microscopy and Microanalysis and Flinders Centre for Marine Bioproducts Development at Flinders University.

Science Daily, 24 February 2022

https://sciencedaily.com

The best climate science you've probably never heard of suggests that humanity can still limit the damage to a fraction of the worst projections

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How a little-discussed revision of climate science could help avert doom

2022-02-23

One of the biggest obstacles to avoiding global climate breakdown is that so many people think there's nothing we can do about it.

They point out that record-breaking heat waves, fires, and storms are already devastating communities and economies throughout the world. And they've long been told that temperatures will keep rising for decades to come, no matter how many solar panels replace oil derricks or how many meat-eaters go vegetarian. No wonder they think we're doomed.

But climate science actually doesn't say this. On the contrary, the best climate science you've probably never heard of suggests that humanity can still limit the damage to a fraction of the worst projections if—and, we admit, this is a big if—governments, businesses, and all of us take strong action starting now.

The science we're referencing is included in the UN Intergovernmental Panel on Climate Change's most recent report, issued last August. But first, some context.

For many years, the scientific rule of thumb was that a sizable amount of temperature rise was indeed locked into the earth's climate system. Scientists believed—and told policymakers and journalists, who told the public—that even if humanity hypothetically halted all heat trapping emissions overnight, carbon dioxide's long lifetime in the atmosphere combined with the sluggish thermal properties of the oceans would nevertheless keep global surface temperatures rising for 30 to 40 more years. Since shifting to a zero-carbon global economy would take at least a decade or two, temperatures were bound to keep rising for at least another half century.

But guided by subsequent research, scientists dramatically revised that lag time estimate down to as little as 3 to 5 years. The updated finding is included in the IPCC's Sixth Assessment Report, Working Group I, that made headlines last August. Indeed, it underlies the widely-now used concept of a "carbon budget". It allows us to specify (with some uncertainty range) the maximum amount of carbon that we can still burn if we are to keep global surface warming below the critical level of 1.5C (3F).

Most importantly, it tells us that if humanity slashes emissions to zero, global temperatures will stop rising almost immediately.

To its credit, Scientific American did discuss this updated science in a short article last October. But why isn't this reason for cautious optimism more widely known?

There's plenty of blame to go around. Two of the co-authors of this article are climate scientists, while the other is a veteran journalist. We can collectively attest that scientists aren't always the best natural communicators, journalists and scientists typically don't speak the same language, and much gets lost in translation. Add to that the concerted headwind of a fossil fuel industry-funded disinformation campaign, and you have the makings of a substantial breakdown in communication.

That's a shame, because this revised timeline implies a paradigm shift in how humanity can respond the to the climate emergency. The implications fall into three categories—the three P's of psychology, politics, and policies.

Psychology is arguably the most important, for it makes possible the rest. Knowing that global temperature rise can be stopped almost immediately means that humanity is not doomed after all. We can still save our civilization, at least most of it, if we take rapid, forceful action. This knowledge can banish the sense of inevitability that paralyzes people and instead inspire them towards greater resolve and activity.

This psychological shift can in turn transform the politics of climate change, for it can entice more people to join the fight—or to stay in the fight rather than succumbing to despair.

Newcomers to climate action might begin by eating less meat or ditching the gas-guzzler for an electric vehicle. Another key step, the climate scientist Katherine Hayhoe urges, is for people simply to talk more about climate change with family, friends, and co-workers—because you can't solve a problem if you don't even talk about it.

Most important, though, politics must be committed. "Many individuals are doing what they can," the naturalist David Attenborough has said. "But real success can only come if there is a change in our societies and in our economics and in our politics."

That will only happen if many more people vote, march, and otherwise pressure governments and corporations to favor climate protection over climate destruction. For example, the world spent an estimated $5.9

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trillion in 2020 subsidizing fossil fuels, the main driver of global warming. US taxpayers alone subsidize oil and gas drilling by $660 billion a year. Making fossil fuels artificially cheaper in this way tilts the economic playing field so lopsidedly that it hardly matters how many individuals decide to take the train rather than fly.

Astonishingly, even people who consider themselves environmentalists do not always vote. In the US, environmentalists could decide the crucial 2022 mid-term elections in eight swing states if they just bothered to vote, according to data compiled by the nonpartisan Environmental Voter Project. Almost one million people who did vote in the 2020 general election have never voted in a mid-term, the project found.

Finally, changing the politics of climate change can change the policies used to fight it. Measures that once seemed politically impossible—such as the Green New Deal or president Joe Biden's Build Back Better legislation—can suddenly become feasible as some lawmakers get voted out and others get voted in, and even recalcitrant lawmakers still in power begin to calculate the costs of blocking action differently.

Where all this matters most is in highly climate vulnerable communities, especially in the global South. Countless people in these communities have been suffering climate disasters for decades already, because their communities tend to be more exposed to climate impacts and have less financial capacity to protect themselves. For these people, limiting global temperature rise to 1.5 degrees Celsius is not a scientific abstraction but rather "a matter of life and death," Mohammed Nasheed, the former president of The Maldives said at the COP26 UN climate summit last November.

The fact that 30 more years of rising temperatures is not necessarily locked in is tremendously empowering, but it is not a silver bullet. Some impacts are already irreversible, especially ice sheet melting and sea level rise. The IPCC's next report, due for release later this month, will address how societies can adapt to these and other such profound challenges.

Nevertheless, the latest climate science suggests that COP26's goal of keeping 1.5C alive remains within reach—if humanity phases out fossil fuels rapidly and slashes emissions in half by 2030. If we do that, we might still preserve a livable planet for all who deserve it, which is everyone.
~sWashington Post, 23 February 2022

https://washingtonpost.com

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Quantifying Emission Factors and Setting Conditions of Use According to ECHA Chapter R.14 for a Spray Process Designed for Nanocoatings-A Case Study

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Evaluation of the binding performance of flavonoids to estrogen receptor alpha by Autodock, Autodock Vina and Surflex-Dock

The Effects of E-Cigarette Aerosol on Oral Cavity Cells and Tissues: A Narrative Review

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