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

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ASIA PACIFIC

Industrial Chemicals Environmental Management Standard - IChEMS

2021-12-10

Improving chemicals regulation

All Australian governments are working together to strengthen chemicals management laws to protect our land, air and water.

We have established the Industrial Chemicals Environmental Management Standard – or IChEMS – to help industry and governments manage the environmental risks of chemicals.

IChEMS is a national approach to managing chemical use, storage, handling and disposal. It will deliver more consistent regulation and make it easier for industry to choose less harmful chemicals.

This work is being delivered in two stages.

Phase 1 includes the creation of legislation. The [Industrial Chemicals Environment Management \(Register\) Act 2021](#) passed both houses of parliament on 18 March 2021.

Under the Act, chemicals will be categorised and scheduled on the IChEMS Register based on their level of concern to the environment. This will help government, industry and the community make informed choices about chemicals.

The IChEMS Register will be a single consistent source of information on how chemicals should be managed.

Before chemicals are scheduled, the IChEMS Register and decision-making principles must be made. An expert advisory committee must also be appointed.

In phase 2, the IChEMS Register will be incorporated into the laws of each jurisdiction.

This means environmental risks will be managed consistently across states and territories, in Commonwealth areas and at Australia's borders.

A consistent system to regulate chemicals will result in better protection of human health and the environment. It will make it easier and more efficient for industry to manage chemical risks.

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We'll continue to provide updates on our progress during this phase.

[Read More](#)

Australia Government, 10 December 2021

<https://www.awe.gov.au/environment/protection/chemicals-management/national-standard>

China to Update VOC Standards for Coatings by 2025

2021-01-21

China initiated the Three-year Action Plan on Defending Blue Sky in 2018, which highly prioritized the formulation of the standards to control the emissions of volatile organic compounds (VOCs). In 2019 and 2020, six mandatory national standards (see above) for VOCs control in coatings published. Together with GB 24613-2009 which was published in 2009, they serve as a strong support for VOCs management.

Under the established standards, special functional coatings are exempt from content limitation of VOCs. However, there is no specific list or identification criteria for special functional coatings, which currently only are ambiguous descriptions, such as simulated plating-silver effect coatings, insulation coatings and touch screens, etc. To make it clear, a series of group standards will be set. In 2021, China has drafted T/CSTM 00637-2022 Simulated Plating-silver Effect Coatings, which detailed the requirements the simulated plating-silver effect coatings should conform to, including electronic appliances, and surface decoration of automobile interior parts, etc. Two or more group standards are expected to be issued in 2022. These group standards may be cited or even the contents may be included in the three national mandatory standards to be issued by 2025.

[Read More](#)

Chemlinked, 20 January 2022

<https://chemical.chemlinked.com/news/chemical-news/china-to-update-voc-standards-for-coatings-by-2025>

Under the established standards, special functional coatings are exempt from content limitation of VOCs. National Technical Committee on Paints & Pigments of Standardization Administration of China is planning to revise and integrate the current seven national mandatory standards on limits of harmful substances of coatings into three by 2025. The revised standards will cover more products and introduce more advanced technical indicators, which can better guarantee the high-quality green development of the coating industry.

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Safety assured: Australian food supply not contaminated by chemicals in foam used to fight bushfires

2021-01-31

Food Standards Australia New Zealand (FSANZ) has confirmed that the Australian food supply has not been contaminated by chemicals from firefighting foam used to tackle bushfires.

[Read More](#)

Food Navigator, 31 January 2022

<https://www.foodnavigator-asia.com/Article/2022/01/31/safety-assured-australian-food-supply-not-contaminated-by-chemicals-in-foam-used-to-fight-bushfires>

AMERICA

Willingboro residents fear PFAS in drinking water. Township shut down the offending well and says water is safe to drink

2021-12-15

Residents of Willingboro, Burlington County, recently learned one of the township's water supply wells has elevated levels of one type of the group of toxic chemical compounds known as PFAS, which are linked to some cancers and other health issues. Township officials say that the well was taken offline, and that the water is safe to drink.

A [letter](#) to residents posted on the Willingboro Municipal Utilities Authority website last week says PFOS, or perfluorooctane sulfonate, is present at an average annual rate of .0155 micrograms per liter, measured over the past year. At a maximum contaminant level of 0.013 micrograms per cubic liter for PFOS, and .014 micrograms per cubic liter for PFOA, New Jersey has the most [stringent regulations](#) in the country when it comes to these so-called "forever chemicals."

The levels detected in Willingboro's water supply are much lower than in communities near some military bases, where firefighting foam contaminated drinking water. They are also far lower than the EPA's advisory level.

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[Read More](#)

WHYY, 15 December 2021

<https://whyy.org/articles/willingboro-residents-fear-pfas-in-drinking-water-township-shut-down-the-offending-well-and-says-water-is-safe-to-drink/>

FDA Releases Opinions on Asbestos Testing in Talc-containing Cosmetics

2022-01-20

The U.S. Food and Drug Administration released a white paper developed by the Interagency Working Group on Asbestos in Consumer Products (IWGACP) that contains scientific opinions for the testing of talc-containing cosmetics and talc intended for use in cosmetics for the possible presence of asbestos, a known human carcinogen with well-documented health risks.

Identify & Report Presence of Asbestos

The white paper, "Scientific Opinions on Testing Methods for Asbestos in Cosmetic Products Containing Talc (including Talc Intended for Use in Cosmetics)," outlines the scientific opinions of the IWGACP related to the detection and identification of asbestos fibers in talc-containing cosmetic products. These opinions are important given the long-recognized shortcomings of other methods in use in their ability to detect asbestos.

The method voluntarily adopted by the cosmetics industry in 1976, Cosmetic, Toiletry, and Fragrance Association, relies on Polarized Light Microscopy (PLM) if amphibole minerals are first detected by X-ray diffraction. However, recent testing of cosmetics using Transmission Electron Microscopy (TEM) has revealed the presence of asbestos fibers in samples that had negative findings for the same products using PLM.

It includes the following related advice: utilizing both PLM and TEM to identify and report the presence of asbestos, reporting all asbestos and

The FDA, in its efforts to protect public health, has ongoing sampling and testing to assess for the presence of asbestos in talc-containing cosmetics. The FDA's previous and current talc-containing cosmetics sampling assignments have used PLM and TEM to detect asbestos.

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other similar particles greater than or equal to 0.5 μm in length with a length to width aspect ratio greater than or equal to 3-to-1.

Efforts to Help Ensure Safety of Cosmetics

Providing analytical reports with adequate documentation of findings, and establishing policies and procedures covering training, quality assurance, and quality control, to accompany testing methods, to ensure laboratories are qualified and their qualifications are reviewed on a regular basis.

The FDA, in its efforts to protect public health, has ongoing sampling and testing to assess for the presence of asbestos in talc-containing cosmetics. The FDA's previous and current talc-containing cosmetics sampling assignments have used PLM and TEM to detect asbestos.

"The FDA has been sampling and testing talc-containing cosmetics for asbestos as part of our overall efforts to help ensure the safety of cosmetics in the U.S. marketplace. We have become aware that methods employed by some industry members to test for asbestos in talc-containing cosmetic products may not always detect the presence of asbestos," said Susan Mayne, Ph.D., director of the FDA's Center for Food Safety and Applied Nutrition. "That's why an interagency working group sought to take a state-of-the-science look at available methods."

FDA Plans to Peer-review the White Paper

The FDA plans to have the white paper peer-reviewed as part of its consideration of these scientific opinions when formulating next steps in a regulatory process to address asbestos contamination in talc-containing cosmetic products. The scientific opinions set forth in the white paper could potentially be used to support regulatory policy developments on a definition of particles of interest and standardized testing methods for asbestos and other mineral particles that could potentially affect talc-containing cosmetic product safety.

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In February 2020, the FDA hosted a public meeting to solicit information on asbestos testing methods. The IWGACP was formed by the FDA and consists of subject matter experts from U.S. federal agencies. The IWGACP considered the comments and information received at the public meeting and from the docket, to inform the development of its scientific opinions.

[Read More](#)

Special Chem, 20 January 2022

<https://cosmetics.specialchem.com/news/industry-news/fda-opinions-on-testing-for-asbestos>

EPA moves to reject industry request to change assessment of risks posed by carcinogen

2022-01-22

The Environmental Protection Agency (EPA) on Wednesday proposed rejecting an industry request to change the findings it uses on the risks posed by a chemical the agency considers to be cancer-causing.

In a [new proposal](#), the agency said that it wants to stick by its 2016 findings on the dangers of inhaling ethylene oxide, which underpin 2020 regulations on the substance.

In doing so, it is snubbing [requests from industry](#) to instead use an assessment from the Texas Commission on Environmental Quality, which found the substance to be significantly less dangerous than the EPA did.

Industry has pushed back against the Trump-era regulation on ethylene oxide, which is used to make other chemicals and sterilize medical equipment.

A [petition](#) from the American Chemistry Council, which had asked the EPA to use the Texas finding, has noted that if the agency had done so, it may have ultimately decided against more regulation.

But, environmentalists [have raised concerns](#) about the Texas finding and sued to try to make the state release certain documents behind the finding.

The EPA in its latest decision said that the Texas assessment and requests for reconsideration "do not provide a scientifically supportable basis" for relying on the state's finding.

The Environmental Protection Agency (EPA) on Wednesday proposed rejecting an industry request to change the findings it uses on the risks posed by a chemical the agency considers to be cancer-causing.

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In a statement, EPA Administrator [Michael Regan](#) said the agency was taking this action to protect communities.

“People living near chemical plants are increasingly concerned about exposure to ethylene oxide, and the science shows it is a potent air toxic posing serious health risks,” he said in a statement. “Today we reinforce and advance EPA’s commitment to protect overburdened communities by following the best available science and data.”

[Read More](#)

The Hill, 27 January 2022

<https://thehill.com/policy/energy-environment/591479-epa-moves-to-reject-industry-request-to-change-assessment-of-risks>

Judge: DNR can sample for ‘forever chemicals’ but can’t take action against polluters until standards are passed

2022-01-27

Jefferson County Judge William Hue said in a written decision Monday that under the Clean Water Act, the agency can continue to sample for PFAS for informational purposes, but enforcement can’t be taken. He also ruled that any sampling results should be considered public record, and therefore subject to records requests.

The 45-page decision partially sides with Wisconsin Manufacturers & Commerce, which sought to halt the agency’s sampling program last year with the lawsuit.

WMC in April 2021 filed for a [restraining order to temporarily halt the Department of Natural Resources PFAS sampling program](#) because the agency did not have the authority to implement and enforce sampling for compounds that do not yet have standards under state law.

[Read More](#)

Milwaukee Journal Sentinel, 27 January 2022

<https://www.jsonline.com/story/news/local/wisconsin/2022/01/26/dnr-can-sample-forever-chemicals-but-cant-take-action-against-polluters/6507547001/>

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Pollution Trends And US Environmental Policy: Lessons From The Last Half Century – Analysis

2022-02-02

Half a century has passed since the US enacted a slate of environmental legislation in the 1970s, including the Clean Air Act, Clean Water Act, and Safe Drinking Water Act. This column reviews the literature and shows that air and water pollution are declining but greenhouse gas emissions are not because CO2 has been targeted less by environmental policy. These trends appear to provide large net benefits to US society and using cost-effective market-based policies does not appear to have systematic implications for the equality of environmental outcomes.

In the 1960s and 1970s, concern for US environmental quality grew rapidly. This growth had many causes, including an oil spill off the coast of Santa Barbara, photos of Earth taken from space, and a fire on the Cuyahoga River in Cleveland. Spurred on by these concerns, the federal government passed a slate of environmental legislation in the early 1970s, including the Clean Air Act, Clean Water Act, Safe Drinking Water Act, and many others. These laws had enormous bipartisan support.

A half century has passed since enactment of these laws, making it a good time to assess what has been learned from 50 years of environmental policy and economic research. Several studies have summarised what research and policymakers have learned about specific individual laws or pollutants (Olmstead 2010, Currie and Walker 2019, Schmalensee and Stavins 2019, Keiser and Shapiro 2019b).

In a recent review, I seek to provide a broad overview of pollution trends, policy impacts, and distributional consequences, which might be overlooked in a single research paper or when examining a single policy, pollutant, or method in isolation (Shapiro 2021). In the review, I assess the evidence for four hypotheses:

Hypothesis 1: Air pollution, drinking water pollution, and surface water pollution have declined substantially over the last several decades, although CO2 emissions have not.

In the 1960s and 1970s, concern for US environmental quality grew rapidly

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Hypothesis 2: Environmental policy explains a large share of long-term decreases in air and water pollution.

Hypothesis 3: Air and drinking water policies have tended to produce benefits that exceed their costs; the evidence for surface water is much less clear.

Hypothesis 4: While the distribution of pollution across social groups is unequal, market-based policies and command-and-control policies do not have systematically different effects on the distributions of environmental outcomes.

I also highlight recent innovations in methods and data that have improved researchers' ability to test these hypotheses. These advances include the use of administrative data on environmental goods; use of statistical cost-benefit tests; a focus on important but understudied policies; more sophisticated models of how pollution emissions in one location affect ambient pollution concentration in other locations (i.e. pollution transport); micro-macro frameworks that combine detailed data on individual firms and households with macroeconomic models of the entire economy; and a focus on how policy affects the distribution of environmental outcomes, particularly for low-income communities and communities of colour. I discuss each hypothesis in turn.

[Read More](#)

Eurasia Review, 2 February 2022

<https://www.eurasiareview.com/05122021-pollution-trends-and-us--environmental-policy-lessons-from-the-last-half-century-analysis/>

EUROPE

How a Cotswolds river may show the way to clean up England's waterways

2022-02-02

The Evenlode in Oxfordshire, UK, has been plagued by pollution, but farmers, the water industry and local volunteers are working together to clean it up

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"It's depressing. It's something we should be able to put right," says Mark Purvis, standing next to a brook feeding the Evenlode, a river in the Cotswolds area of southern England that has been plagued with water pollution in recent years. "We've seen declines in numbers of fish, insects and weed growth in the river. And terrible turbidity [cloudiness] in summer," he says.

The Evenlode's problems aren't unique. England's rivers are "a mess", a [report by MPs in the Environmental Audit Committee \(EAC\) concluded last month](#), due to a lack of funding and monitoring

[Read more](#)

New Scientist, 2 February 2022

<https://www.newscientist.com/article/2306097-how-a-cotswolds-river-may-show-the-way-to-clean-up-englands-waterways/#ixzz7JnykzzUX>

IEEFA: European-based regulatory model has global implications for complex plastics questions

2022-02-01

In May 2018, the European Commission unveiled a process to establish a classification system of suitable economic activities to achieve low-carbon goals for the European Union. The "taxonomy" as it is called, is designed to result in a framework for sustainable investment, a supportive disclosure protocol and a baseline for low-carbon initiatives. The regulations will create the rules of the road for the long-term economic transition in Europe and shape global discourse.

The regulatory process sends a signal to capital markets and petrochemical producers that the circular economy will be operationalized with supportive policy initiatives. The message is already having an impact. Major players on the petrochemical sector are [designing new facilities](#) that comply with the basic tenets.

Expanding the definition to include half of ethylbenzene because of its use in the production of styrene (packaging), and perhaps less than one-third

The "taxonomy," as it is called, is designed to result in a framework for sustainable investment, a supportive disclosure protocol and a baseline for low-carbon initiatives

The Evenlode in Oxfordshire, UK, has been plagued by pollution, but farmers, the water industry and local volunteers are working together to clean it up

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of ethylene oxide because of its use in the production of polyethylene terephthalate (PET, used in beverage bottles), the number exceeds 70%.

[Read More](#)

IEEFA, 1 February 2022

<https://ieefa.org/ieefa-european-based-regulatory-model-has-global-implications-for-complex-plastics-questions/>

Use of TTC Cramer Class III (CCIII) value at step 5 of the groundwater (gw) metabolite relevance assessment of PPPs

2022-02-04

The Chemicals Regulation Division (CRD) of HSE has developed a paper describing the use of the TTC CCIII value (1.5 µg/kg bw/d) for gw metabolites at step 5 of the relevance assessment of PPPs, when there is no other suitable data to derive metabolite-specific acceptable daily intakes (ADIs).

HSE considers it to be a scientifically valid approach which is consistent with the [SANCO \(2003\) gw relevance assessment guidance \(PDF\)](#) (the EU guidance currently applicable in GB relevant to this specific aspect of the evaluation).

The paper is available to download from our Pesticides website:

[TTC and groundwater metabolites \(PDF\)](#)

HSE is committed to minimise unnecessary animal testing, with *in vivo* vertebrate studies being seen as the last resort (Art. 62 of Regulation (EC) No 1107/2009). For gw metabolites which are not structurally or toxicologically similar to the parent active substance or for which a read-across from a data-rich analogue is not possible, the SANCO (2003)

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guidance requires at step 5 the generation of repeated dose toxicity studies in experimental animals to establish metabolite-specific ADIs for the subsequent dietary risk assessment.

The paper developed by HSE describes how the TTC CCIII value can be used as an alternative to studies in experimental animals, leading to a significant reduction in unnecessary animal testing. However, it should only be used when it is considered scientifically justified, in line with the most recent [EFSA \(2019\) guidance on TTC](#).

HSE deems that such an approach provides a thoroughly considered, scientifically supported and justified precedent, which leads to reduction of unnecessary animal testing, without compromising on protection goals.

The approach was fully supported by the independent scientific advisory committee, the Expert Committee on Pesticides (ECP).

[Read More](#)

HSE, 4 February 2022

<https://www.hse.gov.uk/pesticides/resources/T/tcc-and-groundwater-metabolites.pdf>

The Chemicals Regulation Division (CRD) of HSE has developed a paper describing the use of the TTC CCIII value

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REACH Update

FEB. 11, 2022

Next steps in the EU re-evaluation of glyphosate

2021-12-02

The comments and observations received through the consultations have been shared with the AGG, who will consider and respond to them.

For the classification process, the AGG will provide its responses to ECHA's Committee for Risk Assessment (RAC). The RAC will develop its opinion on the classification of glyphosate under the Classification, Labelling and Packaging (CLP) Regulation. This is expected in May/June 2022.

For EFSA's assessment, following the AGG's evaluation of the comments received through the consultation, a clock stop could be applied to request additional information from the Glyphosate Renewal Group (GRG). An updated assessment (RAR) will then be produced by the AGG and will be sent to EFSA to proceed with the peer review. EFSA will take the outcome of ECHA's opinion into account in its peer review, which is expected to be finalised in the second half of 2022.

Regular updates on the work can be found on the EFSA and ECHA websites.

[Assessment Group on Glyphosate](#)

[Glyphosate on EFSA website](#)

[Glyphosate consultation by ECHA](#)

[Glyphosate consultations by EFSA](#)

[Read More](#)

ECHA, 2 December 2021

<https://echa.europa.eu/hot-topics/glyphosate>

European Commission – Restriction of highly hazardous substances in single-use baby diapers

2022-01-22

The European Environmental Bureau's Secretary General wrote a letter appealing to the European Commission to accept the French authorities (ANSES) proposal to restrict a group of extremely hazardous substances in baby diapers throughout the EU under the REACH Regulation. The letter has been co-signed by several other civil society organisations.

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With this letter, we would like to ask for the European Commission to support the proposed restriction. In making their decision, we draw attention to their key responsibility to take into account the particular vulnerability of the newborns and toddlers that this important restriction aims to protect.

[Read More](#)

EEB, 26 January 2022

<https://eeb.org/library/open-letter-european-commission-restriction-of-highly-hazardous-substances-in-single-use-baby-diapers/>

For EFSA's assessment, following the AGG's evaluation of the comments received through the consultation, a clock stop could be applied to request additional information from the Glyphosate Renewal Group (GRG)

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Janet's Corner

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What I learned in the lab

2022-02-11

WHAT I LEARNED IN THE LAB:

HOT GLASS LOOKS THE SAME AS COLD GLASS



<https://www.calpaclab.com/science-jokes/>

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Hazard Alert

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Cyanide

2022-02-11

A cyanide is a chemical compound that contains the cyano group, $-C \equiv N$, which consists of a carbon atom triple-bonded to a nitrogen atom. [1]

Cyanide is very reactive, forming simple salts with alkali earth cations and ionic complexes of varying strengths with numerous metal cations; the stability of these salts is dependent on the cation and on pH. The salts of sodium, potassium and calcium cyanide are quite toxic, as they are highly soluble in water, and thus readily dissolve to form free cyanide. [2] Hydrogen cyanide is a colourless gas with a faint, bitter, almond-like odour. Sodium cyanide and potassium cyanide are both white solids with a bitter, almond-like odour in damp air. [3]

USES [4]

Cyanide salts are mainly used in electroplating, metallurgy, the production of organic chemicals (acrylonitrile, methyl methacrylate, adiponitrile), photographic development, the extraction of gold and silver from ores, tanning leather and in the making of plastics and fibres. They are also used to manufacture fumigation chemicals, insecticides and rodenticides.

SOURCES OF EMISSION & ROUTES OF EXPOSURE

Sources of Emission

- Industry sources: Silver and gold mining operations (water or soil release), chemical processing facilities (water or air release), steel and iron industries (water or air release), metallurgical industries (water release), metal plating and finishing facilities (water release) and petroleum refineries are the largest point sources of cyanide (water or air release).
- Diffuse sources: Use of pesticides (air, water, soil release) Burning of waste, tobacco products, certain plastics, wool, silk, and paper release cyanide to the air. Metal cleaning facilities tanneries, and photographic facilities may release cyanide to the air or water.
- Natural sources: Some plants manufacture certain chemicals which when they decompose release cyanide. One of these chemicals (amygdalin) is found in the pits of apricots, peaches, cherries, apples, pears, and similar fruits and in sweet almonds. Enzymes in the human intestine are capable of releasing cyanide from this chemical, resulting

A cyanide is a chemical compound that contains the cyano group, $-C \equiv N$, which consists of a carbon atom triple-bonded to a nitrogen atom.

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in poisoning. Certain blue-green algae can produce cyanide as they metabolise nitrates.

- Transport sources: Perhaps the largest source of mobile emissions of cyanide to the air is motor vehicle exhaust.
- Consumer products: Consumer products containing cyanide products are pesticides, rodenticides, and other animal poisons, silver and metal polishes and photographic solutions.

Routes of Exposure [5]

- Inhalation – Minor route of exposure for the general population. Primary route of occupational exposure.
- Oral– Primary route of exposure for general population. The intake of naturally occurring cyanide in food is likely to be higher than the intake of cyanide from drinking water and inhalation exposure.
- Dermal – Minor route of exposure

IN THE ENVIRONMENT [3]

- Cyanide enters air, water, and soil from both natural processes and industrial activities.
- In air, cyanide is mainly found as gaseous hydrogen cyanide; a small amount is present as fine dust particles.
- The half-life (the time needed for half of the material to be removed) of hydrogen cyanide in the atmosphere is about 1– 3 years.
- Most cyanide in surface water will form hydrogen cyanide and evaporate.
- Cyanide in water does not build up in the bodies of fish.
- Cyanides are fairly mobile in soil. Once in soil, cyanide can be removed through several processes. Some cyanide compounds in soil can form hydrogen cyanide and evaporate, whereas some cyanide compounds will be transformed into other chemical forms by microorganisms in soil. At the high concentrations, cyanide becomes toxic to soil microorganisms. Because these microorganisms can no longer change cyanide to other chemical forms, cyanide is able to pass through soil into underground water.

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HEALTH EFFECTS [6]

Acute Effects

Cyanide is extremely toxic to humans. Acute (short-term) inhalation exposure to 100 milligrams per cubic metre (mg/m^3) or more of hydrogen cyanide will cause death in humans. Acute exposure to lower concentrations (6 to $49 \text{ mg}/\text{m}^3$) of hydrogen cyanide will cause a variety of effects in humans, such as weakness, headache, nausea, increased rate of respiration, and eye and skin irritation. Tests involving acute exposure of rats and mice have shown hydrogen cyanide to have extreme acute toxicity from inhalation exposure.

Chronic Effects

Chronic exposure to cyanide in humans via inhalation results in effects on the CNS, such as headaches, dizziness, numbness, tremor, and loss of visual acuity. Other effects in humans include cardiovascular and respiratory effects, an enlarged thyroid gland, and irritation to the eyes and skin. Animal studies have reported effects on the nervous, cardiovascular, and respiratory systems. The Reference Concentration (RfC) for hydrogen cyanide is $0.003 \text{ mg}/\text{m}^3$ based on CNS symptoms and thyroid effects in humans. The Reference Dose (RfD) for cyanide and hydrogen cyanide is 0.02 milligrams per kilogram body weight per day ($\text{mg}/\text{kg}/\text{d}$) based on weight loss, thyroid effects, and myelin degeneration in rats.

Reproductive/Developmental Effects

No studies were located on the reproductive or developmental effects of cyanide in humans from inhalation exposure. Animal studies have suggested that oral exposure to cassava (a cyanide-containing vegetable) may be associated with malformations in the foetus and low foetal body weights.

Cancer Risk

No studies were located on the carcinogenic effects of cyanide, from inhalation or oral exposure, in humans or animals. EPA has classified cyanide as a Group D, not classifiable as to human carcinogenicity.

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SAFETY [7]

First Aid

- Eye Contact: Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.
- Skin Contact: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
- Serious Skin Contact: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
- Serious Inhalation: Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation.
- WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.
- Ingestion: If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Fire Hazards

Cyanides are dangerous when in contact with acids, acid fumes, water or steam. It will produce toxic and flammable vapours of CN-H and sodium oxide. Contact with acids and acid salts causes immediate formation of toxic and flammable hydrogen cyanide gas. When heated to decomposition it emits toxic fumes hydrogen cyanide and oxides of nitrogen. Fusion mixtures of metal cyanides with metal chlorates, perchlorated or nitrates cause a violent explosion.

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Exposure Controls & Personal Protection

Engineering Controls

Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protective Equipment

The following personal protective equipment is recommended when handling cyanides:

- Splash goggles;
- Synthetic apron;
- Vapour and dust respirator (Be sure to use an approved/certified respirator or equivalent);
- Gloves

Personal Protection in Case of a Large Spill:

- Splash goggles;
- Full suit;
- Vapour and dust respirator;
- Boots;
- Gloves;
- A self-contained breathing apparatus should be used to avoid inhalation of the product.
- Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

REGULATION [2,4,6]

United States

- EPA regulates the levels of cyanide that are allowable in drinking water. The highest level of cyanide allowed in drinking water is 0.2 parts cyanide per 1 million parts of water (0.2 ppm).
- The Occupational Safety and Health Administration (OSHA) has set a limit for hydrogen cyanide and most cyanide salts of 10 parts cyanide per 1 million parts of air (10 ppm) in the workplace.

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- NIOSH has set a 15-minute short-term exposure limit of 5mg/m³ for hydrogen, calcium, potassium and sodium cyanide.

Australia

- Worksafe Australia: For Hydrogen cyanide, eight hour time weighted average (TWA) exposure limit: 11 5mg/m³. For other cyanide compounds, the TWA exposure limit is 5mg/m³.
- Worksafe Australia reports hydrogen cyanide, potassium cyanide, and sodium cyanide are all very toxic by inhalation.

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Plants Face Tough Climate Challenges as Seed-Dispersing Animals Decline

2022-02-02

Animals that eat fruit and spread the seeds in their droppings offer an all-inclusive transportation service for half the world's flora. But as more seed-dispersing birds and mammals die off globally, some of these plant species will lose their ability to shift their locations to keep pace with escalating climate change, says new research.

"When you hear the headlines about the biodiversity crisis, some call it the sixth mass extinction, that decline of birds and mammals also means the decline of seed dispersers," Evan Fricke, lead author of the new study, recently published in Science, said.

Fricke and colleagues reported that the loss of birds and mammals has reduced the ability of animal-dispersed plants to track climate change by 60%.

This number "is somewhere in the alarm bell territory," he said. "I hope [this finding] focuses people's attention on the importance of seed-disperser biodiversity for plant adaptation to climate change."

"If there are no animals available to eat their fruits or carry away their nuts," Fricke said in a press release, "animal-dispersed plants aren't moving very far."

As the climate warms, many species will need to change locations to stay within a temperature range that they can tolerate. On a mountain, this might mean they move upslope by just a few to tens of meters per year. On flatter terrain, organisms need to move toward the poles, perhaps hundreds of kilometers, to keep pace with climate change. The speed at which suitable climate zones move across the landscape (also known as the climate change velocity) is faster, and therefore more challenging, for plants to track on flat land.

While animals can crawl, fly, swim or walk to new places, plants cannot pick up and move. So the question, Fricke said, becomes: "How many seeds disperse at least that distance that the climate has shifted during the year? How many seeds are dispersed far enough to keep pace with that climate change?"

In the past, scientists have studied what the loss of seed-dispersing animals means for plants in ecosystems, and they've also studied how plant populations respond to climate change. But combining those two

A new study shows how the concerning overlap between the biodiversity and climate crises.

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catastrophes — climate change and mass extinction — on a global scale has been a tougher nut to crack.

To accomplish this goal, the researchers used data from hundreds of past studies to train a machine-learning model to make estimates and conclusions about the loss of seed-dispersal services. The far-ranging data sets analyzed and compared IUCN data on worldwide animal populations; which seeds are dispersed by which animals; where and how far these animals travel; and how long seeds take to pass through the guts of their dispersers.

Seed-dispersal losses, they found, are most extreme in the temperate regions of North America, Europe, South America and Australia. Extinction of the world's current endangered species would most impact dispersal in tropical regions in South America, Africa and Southeast Asia.

"This paper is an elegant analysis of how the loss of animals will affect plants under climate change scenarios," said Mauro Galetti, a seed-dispersal researcher from the University of Miami who was not involved in the study. "The results are worrisome because most natural ecosystems' large fruit-eating animals are vanishing."

The scientists also found that even just a small decline in the number of animal species leads to a massive decline in plants' ability to track climate change. "One might expect that if a location loses 10% of its seed-dispersing animals, we would see a 10% decline in dispersal," Fricke said, "but this is not the case." When animals die off in an ecosystem, we're often first losing the large ones — those that are the best at long-distance dispersal.

"We found regions where climate-tracking seed dispersal declined by 95%, even though they'd lost only a few percent of their mammal and bird species," Fricke said.

"From elephants and gorillas in Africa, to toucans and tapirs in South America, large seed dispersers are vanishing rapidly and their dismissal will have strong consequences on seed dispersal," Galetti said. "Many plants will be trapped in space without seed dispersers."

This first global analysis of the loss of seed-dispersers, according to Fricke, demonstrates the critical interconnectedness of the climate change and biodiversity crises — two of the nine planetary boundaries identified by scientists. The destabilization and overshoot of one or more of these

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boundaries due to human interference could cause the failure of critical Earth operating systems.

"Biodiversity of seed-dispersing animals is key for the climate resilience of plants, which includes their ability to continue storing carbon and feeding people," Fricke said. "Extinction and habitat loss damage complex ecological networks. This study shows animal declines can disrupt ecological networks in ways that threaten the climate resilience of entire ecosystems that people rely upon."

The Revelator, 2 February 2022

<https://therevelator.org/>

50 years ago, researchers thought Americans outgrew marijuana

2022-01-28

Marijuana commission finds usage high — Science News, January 29, 1972

Approximately 24 million Americans have used marijuana at least one time. A national survey reports that more than 8 million are still using the drug... Usage figures are 33 percent higher than the [National Commission on Marijuana and Drug Abuse] had expected, but ... after age 25 pot smoking falls off rapidly.

Update

Americans' interest in marijuana has grown over the last 50 years. Since 1972, the number of people age 12 and older in the United States who, in their lifetimes, have inhaled or ingested the drug has increased more than fivefold, to 126.5 million as of 2020, according to the National Survey on Drug Use and Health. The gain in users happened as the perceived danger of marijuana dropped over time (SN: 6/14/14, p. 16). And unlike in the 1970s, older adults are getting in on the action, though prevalence has risen among adults of all ages. Of the 49.6 million people who reported using pot in 2020, about 47 percent were ages 26 to 49, and about 24 percent were 50 or older.

ScienceNews, 28 January 2022

<https://www.sciencenews.org/article/>

**Excerpt from the
January 29, 1972 issue
of Science News**

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Sudden rise of more transmissible form of Omicron catches scientists by surprise

2022-01-31

On 7 December 2021, as the Omicron variant of the pandemic coronavirus began to pummel the world, scientists officially identified a related strain. BA.2 differed by about 40 mutations from the original Omicron lineage, BA.1, but it was causing so few cases of COVID-19 that it seemed a sideshow to its rampaging counterpart.

"I was thinking: 'BA.1 has the upper hand. We'll never hear again from BA.2,'" recalls Mark Zeller, a genomic epidemiologist at the Scripps Research Institute. Eight weeks later, he says, "Clearly that's not the case. ... I'm pretty sure [BA.2] is going to be everywhere in the world, that it's going to sweep and will be the dominant variant soon in most countries if not all."

Zeller and other scientists are now trying to make sense of why BA.2 is exploding and what its emergence means for the Omicron surge and the pandemic overall. Already a [U.K. report](#) issued last week and a [large household study](#) from Denmark posted this week as a preprint make it clear BA.2 is inherently more transmissible than BA.1, leaving scientists to wonder which of its distinct mutations confer an advantage.

But so far, BA.2 does not appear to be making people sicker than BA.1, which itself poses less risk of severe disease than variants such as Delta and Beta. In Denmark, where by 21 January BA.2 accounted for 65% of new COVID-19 cases, "We see a continuous, steep decline in the number of intensive care unit patients and ... now a decrease in the number of hospital admissions related to SARS-CoV-2," says Tyra Grove Krause, an infectious disease epidemiologist at the country's public health agency. In fact, the Danish government is so confident the variant won't cause major upheaval that it lifted almost all pandemic restrictions on 1 February.

Still, some scientists predict BA.2 will extend Omicron's impact. "I would guess we'll see [BA.2] create a substantially longer tail of circulation of Omicron than would have existed with just [BA.1], but that it won't drive the scale of epidemics we've experienced with Omicron in January," computational biologist Trevor Bedford of the Fred Hutchinson Cancer Research Center [tweeted](#) on 28 January. In South Africa, BA.2 already may be stalling the rapid decline in new infections seen after the country's Omicron wave peaked in December 2021.

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Although BA.2 represented less than 4% of all Omicron sequences in the leading global virus database as of 30 January, it has been identified in 57 countries, with the earliest documented case dating to 17 November in South Africa. It likely now dominates in India, according to Bijaya Dhakal, a molecular biologist at the Sonic Reference Laboratory in Austin, Texas, who examined sequence data uploaded from eight large Indian states. In the United Kingdom, the proportion of likely BA.2 cases doubled from 2.2% to 4.4% in the 7 days that ended on 24 January.

In the United States, the Centers for Disease Control and Prevention is not yet tracking BA.2 separately. But Bedford estimates it accounted for 7% of new U.S. cases as of 30 January, up from 0.7% on 19 January. "In each country and across time, we see that the epidemic growth rate of Omicron BA.2 is greater than Omicron BA.1," he says.

The report last week from the UK Health Security Agency (UKHSA) backs up that assessment in England, finding BA.2 was spreading faster than BA.1 in all regions where enough data were available to make an assessment. UKHSA data also show that in late December 2021 and early January, [transmission was higher among household contacts of BA.2 cases](#), at 13.4%, than in contacts of other Omicron cases (10.3%).

The study from Denmark, which sequences the virus from virtually every person who gets COVID-19, paints a more dramatic picture. In households where the first case was BA.1, on average 29% of other people in the household became infected. When the first case was BA.2, 39% of household members were infected.

Omicron was already known to have mutations that help it evade antibodies, but the Danish researchers also found that BA.2 may be even better at dodging vaccine-induced immunity: Vaccinated and boosted people were three times as susceptible to being infected with BA.2 as with BA.1. Vaccinated but unboosted people were about 2.5 times as susceptible, and unvaccinated people 2.2 times as susceptible. [Early U.K. data](#), however, showed vaccinated people, if boosted, had about the same level of protection against symptomatic infections with BA.1 or BA.2—63% and 70%, respectively.

In one hopeful and unexpected finding from Denmark, those who were vaccinated or vaccinated and boosted passed on BA.2 to household members less often, relative to BA.1. The same didn't hold for unvaccinated people, who passed BA.2 to their household contacts at 2.6 times the rate they passed BA.1.

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Much as scientists a few weeks ago wondered whether a previous infection with Delta or another variant would protect people from Omicron overall, some are now looking for data on whether Omicron's first surge created a shield against BA.2. "To what extent does a BA.1 infection protect you against reinfection with BA.2?" Zeller asks. "From what I have seen in Denmark, it's not going to be 100%."

Scientists are also probing the variant's ability to dodge vaccine-induced antibodies in lab dish studies. And drugmaker GlaxoSmithKline is testing its monoclonal antibody, sotrovimab, made with Vir Biotechnology, against BA.2 in lab studies. It's the only widely authorized antibody that still thwarts BA.1.

Scientists note BA.1 and BA.2 are about as far apart on the evolutionary tree as earlier variants of concern—Alpha, Beta, and Gamma—are from each other (see graphic, below). Some even think BA.2 shouldn't even be considered Omicron. "I hope in the near future that BA.2 gets its own variant of concern [label] because people assume it's very similar which it's not," Zeller says.

BA.2 doesn't have all of the mutations that help BA.1 avoid immune detection, but it has some its sibling doesn't. Thomas Peacock, a virologist at Imperial College London, notes that most of the differences are in an area of the spike protein, called the N-terminal domain (NTD), that houses antibody targets. "What we don't know is: Just because there are changes, are they changes that actually do something?" says Emma Hodcroft, a molecular epidemiologist at the University of Bern.

But one NTD difference—a deletion at amino acids 69 and 70 that is present in BA.1 and not in BA.2—could give researchers a tool for monitoring the spread of the up-and-coming Omicron strain. Certain SARS-CoV-2 polymerase chain reaction tests detect three genetic sequences of the virus, but the mutation in BA.1's NTD gene eliminates one of those targets. Polymerase chain reaction tests pick up all three targets in BA.2, providing a proxy for distinguishing the Omicron strains if there is no full virus sequence.

How the sibling strains were born is also preoccupying scientists. Viral evolution in a single immunocompromised patient is one theory, says Andrew Rambaut, an evolutionary biologist at the University of Edinburgh. "It's possible that long-term infection could produce quite a lot of diversity within a single individual. It could be compartmentalized. So different variants living in different parts of the body." Both Omicron strains could

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have also evolved in animals infected with human-adapted SARS-CoV-2, then spread back into people.

Why BA.2 is emerging only now is one more mystery, Hodcroft says. She speculates that a factor as simple as which Omicron caught an earlier flight out of South Africa, where both strains were first identified, may be the explanation. "BA.2 may have just been trapped for a little bit longer. But when it did finally get out and start spreading it started to show that it can edge out its big sister."

Science, 31 January 2022

<https://www.science.org/>

Killer whales spotted for the first time killing blue whales

2022-02-03

Gangs of killer whales have been spotted chasing, biting, suffocating and then devouring the largest creature on the planet: the blue whale.

Researchers documented these orcas, also called killer whales (*Orcinus orca*), taking down blue whales (*Balaenoptera musculus*) on three separate occasions off the southwestern coast of Australia between 2019 and 2021. Each episode included between 50 and 75 killer whales, and more than a dozen of these orcas took part in all three attacks, according to the study, published online Jan. 21 in the journal Marine Mammal Science. The takedowns seemed particularly brutal, with the orcas jumping on the blue whale's blowhole, dragging it underwater and, on one occasion, snacking on the live whale's tongue.

"These killer whales, they work together a lot and there are a lot of killer whales," study senior researcher Robert Pitman, a marine ecologist at the Marine Mammal Institute at Oregon State University, told Live Science. "That's probably the reason for their success down there."

The three attacks raise the question: Why haven't humans seen such grisly attacks before? The answer may be twofold: the low number of blue whales and the skills of the killer whales hunting them, Pitman said. Blue whales are still recovering from their near extinction from 19th and 20th-century whalers; even today, the species is endangered, according to the International Union for Conservation of Nature. But now, blue whale populations are increasing, including in southern Australia's waters, Pitman said.

Three hunting episodes have been documented Down Under.

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It's likely that orcas preyed on blue whales before the giant cetacean's near extinction, Pitman said. But then, with so few blue whales to hunt, orcas likely focused on other prey. Soon enough, hunting blue whales presumably became a lost art in the orca community. "They probably lost those skills necessary to take down a large whale like that," Pitman said.

Now, it appears that orcas are noticing more blue whales and have figured out hunting strategies that lead to a big kill and feast, especially of the blue whale's tongue, the orcas' "preferred cut of meat," Pitman said.

"It's like trying to stop a train"

Blue whales are hard to grab onto — their flippers can rest in grooves along their body; they have a small dorsal fin; and their tail moves up and down quickly, Pitman said. Moreover, they're fast swimmers. "When I was in Antarctica during whale surveys with the Japanese, the old whalers said they would chase blue whales at 12 knots [14 mph or 22 km/h] for 8 to 10 hours, and the whales would just swim off when [the whalers] were done," Pitman said. «They have incredible endurance.»

Put another way, stopping a blue whale for a whaler or even an orca is "like trying to stop a train," he said. Even so, orcas have found ways to successfully attack blue whales.

The first attack was already underway when a research vessel encountered it on March 21, 2019. About a dozen killer whales attacking a 72-foot-long (22 meters) blue whale had left a severe wound with exposed bone on the whale's head and bite marks on its fins. "The blue whale was still attempting to flee its attackers and was slapping and swiping its tail," the researchers wrote in the study.

The attack continued, with orcas biting and ramming into the blue whale. One female orca even began eating its tongue, and the blue whale died soon after. After that, the number of orcas swelled to about 50 as they feasted, along with seabirds, on the whale's remains.

Tourists and scientists aboard whale-watching vessels witnessed the other two events. The second attack, on April 6, 2019, happened just 15 miles (25 kilometers) from the first. This time, a large group of killer whales of all ages was seen attacking a 39-foot-long (12 m) blue whale calf or pygmy that was roughly twice the length of the orcas. "Although still alive, large chunks of skin and blubber were missing from behind the blue whale's head and along its body," and it suffered from bite and tooth-rake marks, too, the researchers wrote in the study.

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Whenever the whale tried to dive down to escape, the orcas pushed it up toward the surface; then other orcas would swim onto its head and blowhole, so it couldn't breathe, and push it down again. When the calf died, the orcas devoured its body, including its tongue.

This calf was "young enough that maybe it shouldn't have even been away from its mother," Pitman said. It's possible that the orcas separated the calf from its parent, "and she would have just left," Pitman said. "There's nothing she can do about it."

The third attack happened about two years later, on March 16, 2021, when killer whales charged at a blue whale. Whenever the blue whale — a 46-foot-long (14 m) individual, possibly a juvenile — stopped, maybe to rest, the orcas bit its mouth and head. After a substantial chase, the orcas pushed the blue whale underwater "and it was not seen alive again," the researchers wrote in the study.

"The attacks were all very similar — the killer whales were swimming along the side" and grabbed onto the blue whale's dorsal fin, flippers and tail as a way to slow it down, Pitman said. Then, the orcas would slide onto the whale's blow hole to prevent it from breathing and to wear it out.

"This event remains an astonishing encounter," study lead-researcher John Totterdell, a cetacean researcher at the Cetacean Research Centre (CETREC) in Western Australia who saw the first attack in 2019, told Live Science in an e-mail. "Till now, the marine mammal science world and the published literature mostly suggested killer whales were not capable of such feats."

These attacks may be providing a window to the past.

"Maybe we're finally getting to see a little bit of what the world looked like before we eliminated most of the large animals that swim in the sea," Pitman said.

Live Science, 3 February 2022

<https://www.livescience.com/orcas-hunt-and-kill-blue-whales>>

Powerful tools help scientists find a virus's weak spot

2022-02-02

Before the COVID-19 pandemic gripped the world, a deadly virus was already spreading across Asia, the Middle East, and parts of Europe. Known as a nairovirus, the microbial threat causes Crimean-Congo hemorrhagic

Advances in imaging that can map a virus's atomic structure offer new hope in treating some of the trickiest diseases, such as the deadly Crimean-Congo hemorrhagic fever.

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fever, a disease marked by fever, muscle aches, nausea, and bleeding under the skin. The virus kills as many as 40 percent of the people it infects.

Outbreaks are sporadic, and case numbers vary by region, but data suggest they are steadily increasing. In Afghanistan, there were just four confirmed cases in 2007; by 2018, the country reported 483 cases. And while the World Health Organization in 2018 identified Crimean-Congo hemorrhagic fever as one of its top priorities for research and development, there is still no therapeutic to fight it.

Now, consortium of researchers studying the virus's microscopic structure is offering hope that therapeutics—and possibly a vaccine—could be on the horizon.

The science of understanding what an infectious agent looks like at the atomic scale is called structural virology. It's a field that has grown exponentially in recent decades, leading to a rise in vaccines that are designed based on the structure of the pathogen they are trying to thwart. Structural virology delivered the mRNA vaccines approved to fight against COVID-19. And it may even lead to the first-ever successful HIV vaccine, which has eluded scientists for decades.

"Structural virology is a major tool" to help scientists understand how to elicit the strongest antibody response to a pathogen and create the very best vaccines, says Jason McLellan of the University of Texas at Austin. His laboratory solved the structure of the SARS-CoV-2 spike protein, which is critical for infecting human cells and is the basis for the two mRNA vaccines.

"It's not going to lead to every vaccine," he adds. "But do I think it's going to be used in the development of many, if not most, of them going forward? Yes, definitely."

Structural virology, explained

Structural virology strives to understand the basic mechanisms of how a virus infects and invades cells. To do that, "we need to know how the virus is built," says Madhumati Sevvana, a structural virologist at Purdue University.

Sevvana likens structural virology to car mechanics: To work on a vehicle, she says, you have to understand each part of the machine and how they interact with one another. "That's what we are trying to understand by solving the structure of the virus and its components," she says.

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Researchers can then piece together how a virus's proteins enter human cells and replicate, causing infection.

Vaccines developed using structural virology—called structure-based vaccines—use the most infectious part of the virus to help the body produce the strongest antibody response. Structural virology helped reveal that the spike proteins on coronaviruses—including MERS, SARS, and SARS-CoV-2—were key for entering human cells. By solving its structure, researchers could modify the protein in a way that made the resulting mRNA vaccines highly effective.

Researchers use a variety of tools to take close-ups of viruses and proteins, but two are especially important: x-ray crystallography and cryo-electron microscopy, or cryo-EM. Recent improvements to these technologies have allowed for an explosion in structure-based vaccine design, so much so that "I think we will see many more vaccines being developed using this technology," says Sevvana.

X-ray crystallography works by first crystalizing proteins, by immersing proteins in a solution until they crystalize, like rock candy. Then scientists place the crystals in the path of an x-ray beam. When light waves in the beam hit the crystal, they bend and scatter into a specific pattern based on the protein's atomic arrangement, yielding something that looks like a collection of black spots on a white background, McLellan says. In modern labs, computers use these spots as a guide to the crystal's structure and generate a three-dimensional image.

But not all viruses and proteins crystalize well, and that's where cryo-EM comes in. This technique allows scientists to capture images by freezing proteins in a thin layer of ice, then hitting them with a beam of electrons that generates a two-dimensional image. Hundreds of thousands of these projections are taken from various angles, and software combines them to build a three-dimensional model.

For many years, cryo-EM could not produce atomic-level resolution, says Andrew Ward, a structural biologist at the Scripps Research Institute. But a new generation of cameras that came out in 2010 revolutionized the field because they allowed for better resolution and the ability to rapidly take multiple photos—much like today's iPhone cameras.

Since then, x-ray crystallography and cryo-EM have been used to solve the structures of important proteins in viruses such as HIV, Zika, Ebola, influenza—and now the nairovirus that causes Crimean-Congo hemorrhagic fever.

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The case of the transforming protein

Like SARS-CoV-2, which infects humans through its shape-shifting spike protein, Crimean-Congo hemorrhagic fever has a molecule that changes its structure before it infects human cells. Called a surface glycoprotein, this molecule's structure morphs from a rod-like configuration into a triangular shape to initiate an infection.

Scientists believe that a successful vaccine would target the protein's initial rod-like shape, stopping the virus before it morphs into its most infectious state. But to target something with the necessary level of precision, you first need to know exactly what it looks like at the atomic scale.

McLellan's laboratory is part of the research consortium Prometheus, which is made up of seven agencies around the world. His team started by isolating proteins from the antibodies of patients who had recovered from Crimean-Congo hemorrhagic fever. Then they used x-ray crystallography to determine the proteins' pre-infectious shape, reconstructing that first 3D atomic-scale map of the protein.

At the same time, a team from the laboratory of Félix Rey at the Pasteur Institute in Paris, France, determined the protein's infectious shape, forming a complete before-and-after picture of the target protein.

"Any time you see a structure for the first time, it's a pretty incredible feeling," McLellan says. "You're the first person in the history of the world to see what this protein really looks like."

Determining the protein's "before and after" shapes allowed the researchers to locate when and where antibodies bind to the virus and discover how, exactly, they are so effective: One antibody stops the protein from morphing, while the other prevents it from penetrating a human cell. This greater understanding will help researchers build better therapeutics and vaccines, McLellan says.

The future of structure-based vaccines

While structural virology and structure-based vaccine design offer hope for some of the trickiest viruses, they aren't appropriate for all pathogens. For one thing, structural virology focuses on the body's antibody response, but some viruses and parasites are more affected by T-cells, another key player in the immune system, Sevvana says.

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For other viruses, says McLellan, it can be difficult to find potent antibodies in human survivors because the viruses are sudden and acute, and there may not be enough survivors from which to draw blood.

That's one reason McLellan advocates for prototype pathogen preparedness—or preparing for future pathogens, even undiscovered ones.

"When a new pathogen breaks out, there isn't really the time, at least initially, to go through all of these steps" needed to create a therapeutic using structural virology. Instead, he says, researchers can start by targeting a family of viruses.

"We may not know what specific hantavirus might cause an epidemic in the future, but we can assume that many or most of the hantaviruses will be similar," he says. "And so, if we do structure-based vaccine design for one or two prototypical members, then when the new one emerges, we'll be able to translate all of that knowledge."

National Geographic, 2 February 2022

<https://www.nationalgeographic.com/>

Genetically engineered immune cells have kept two people cancer-free for a decade

2022-02-02

In 2010, two blood cancer patients received an experimental immunotherapy, and their cancers went into remission. Ten years later, the cancer-fighting immune cells used in the therapy were still around, a sign the treatment can be long-lasting, researchers report February 2 in Nature.

California resident Doug Olsen was one of the patients. "From a patient's viewpoint, when you're told you're pretty much out of options, the important thing is always to maintain hope. And certainly, I hoped this was going to work," Olsen said at a February 1 news briefing.

The treatment, known as CAR-T cell therapy, used the patients' own genetically engineered immune cells to track down and kill cancerous cells (SN: 6/27/18). Based on the results, "we can now conclude that CAR-T cells can actually cure patients with leukemia," cancer immunologist and study coauthor Carl June of the University of Pennsylvania said at the briefing.

Doctors say long-lasting effects show CAR-T therapy can 'cure' some patients

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Olsen and the other patient had chronic lymphocytic leukemia. Both responded well to initial treatment. But it was unclear how long the modified cells would stick around, preventing the cancer's return.

Cancer doctors and researchers "don't use words like 'cure' lightly or easily," said oncologist and study coauthor David Porter of the University of Pennsylvania at the briefing. But with both patients remaining cancer-free for more than a decade, he said, the therapy has performed "beyond our wildest expectations."

The biggest disappointment is that the immunotherapy doesn't work for everyone, Porter added. Some people don't respond to the treatment. Others can develop dangerous side effects (SN: 1/17/20). But researchers are "starting to learn the mechanism of why and how it works, so that we can start to get at how to make it work for more people," he said.

ScienceNews, 2 February 2022

<https://www.sciencenews.org/> >

Malaria-preventing bed nets save children's lives—with impacts that can last for decades

2022-02-02

Since the 1990s, bed nets impregnated with insecticides have been an invaluable tool for malaria prevention. Babies and young children who sleep under them are far less likely to die of the disease. But some scientists have worried this might increase the risk of contracting malaria later in life by preventing development of the immunity that protects older children and adults in areas where malaria is common. Now, an ambitious new study allays those fears. Thousands of people who slept under bed nets as youngsters in the late 1990s and early 2000s in Tanzania still have a significant survival advantage through young adulthood over peers who did not.

"It is a powerful demonstration of the long-lasting payoffs of protecting the health of young children," says Pedro Alonso, director of the World Health Organization's Global Malaria Programme, who was not involved in the new study. It's also encouraging news for global health experts as they plan to roll out a new vaccine against malaria. That vaccine also aims to prevent the disease in the youngest, most vulnerable age groups, raising similar worries of a rebound effect.

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Insecticide-treated bed nets, which prevent mosquitoes from biting people—and kill the insects on contact—were first systematically studied in the 1990s. Most studies only lasted a few years; the longest stretched just 7.5 years. Scientists from the Ifakara Health Institute (IHI) in Dar es Salaam, Tanzania, studied the nets' effect on the health of 6706 babies and toddlers born between 1998 and 2000. By the end of the study, children who slept under the nets had a 27% increased chance of survival. (Because malaria leaves children more vulnerable to other diseases, researchers often measure "all-cause mortality" to assess the effects of malaria prevention measures.)

Twenty years later, the researchers wondered what had become of the children in the study, so they decided to track down as many of them as they could. The bed net study had been part of a larger health survey that built up extensive personal connections in the region, says Sigilbert Mrema, an IHI demographer who led the work with IHI epidemiologist Salim Abdulla. By asking community leaders, family members, neighbors, and other contacts, the researchers and their colleagues tracked down what happened to 89%, or 5983, of the children in the original study. That is "really remarkable," Alonso says.

"People were really happy to be involved," says Joanna Schellenberg, an epidemiologist at the London School of Hygiene & Tropical Medicine who helped lead both the original study and the follow-up.

The researchers found the survival advantage first seen in 2003 was still apparent 20 years later. Children who had slept under bed nets more than half the time in the original study had a 40% survival advantage over children who used them less than half the time, the researchers report today in *The New England Journal of Medicine*. And the protective effect of the nets was apparent even after they controlled for family income, parents' education, and distance from a health care center.

The findings put to rest the worry that bed nets delay deaths rather than preventing them, says malaria researcher Thomas Eisele of Tulane University, who wasn't involved in the work. "The early gains really do persist," Eisele says. "There is never this big leap in mortality."

One reason may be that nets never provide "perfect protection," says Günther Fink, an epidemiologist at the Swiss Tropical and Public Health Institute who helped coordinate the follow-up study. Instead, they reduce the exposure of children to mosquito-borne disease during their most vulnerable years. Later, when children are older and less likely to be using nets, "the [infected] bites arrive," Fink says. But by then the children are

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stronger and can build up some immunity without a high risk of severe disease or death.

Eisele notes that programs to distribute bed nets were accompanied by other malaria control measures, including rapid tests and effective drugs that also help lower the overall number of malaria infections, leaving children less vulnerable to any possible rebound effect.

The results are also reassuring for those deciding how to use the newly approved malaria vaccine, which offers incomplete protection that seems to fade over time—prompting fears it might not have a long-term benefit. The new study demonstrates that even modest investments and imperfect tools “have a long-lasting impact in individuals’ lives,” Alonso says. Protecting the most vulnerable, small children in high-risk areas, “really pays off long term.”

Science, 2 February 2022

<https://www.science.org/> >

These 4 risk factors may increase your chance of long COVID, study hints

2022-02-02

Scientists identified four risk factors that may help predict whether a person will develop long COVID, where an individual experiences various symptoms for weeks or months after their initial COVID-19 infection ends.

The risk factors are: a high quantity of SARS-CoV-2 genetic material in the blood early in infection; an active infection with Epstein-Barr virus (EBV), a different pathogen; certain autoantibodies, or immune molecules that target the body’s proteins, instead of targeting viruses or bacteria; and a pre-existing diagnosis of type 2 diabetes, the most common form of diabetes, in which the body’s cells are resistant to insulin.

Most of these risk factors can be flagged at the time that a patient is first diagnosed with COVID-19, raising the possibility that prompt treatments could potentially prevent some cases of long COVID, according to the new study, published Jan. 24 in the journal Cell.

Still, the study is only a starting point. Researchers must do more work to understand if and how these risk factors actually drive the development of long COVID, and whether these signals that can be spotted early on can help predict which specific symptoms might linger in patients four, eight or 12 months down the line, first author Yapeng Su, who was a research

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scientist at the Institute for Systems Biology in Seattle at the time of the study, told Live Science in an email.

“I think it’s a very well-done study,” said Dr. P. J. Utz, a professor of medicine and physician scientist in immunology and rheumatology at Stanford University, who was not involved in the research.

Utz is one of several Stanford researchers who will serve as principal investigators for the Researching COVID to Enhance Recovery (RECOVER) Initiative, a multi-center study of long COVID sponsored by the National Institutes of Health (NIH). This preliminary research conducted by Su and his colleagues “gives us a great sign post” for how to approach the much larger RECOVER Initiative, which will include tens of thousands of people, Utz said.

Making sense of the risk factors

In the new study, the team monitored nearly 210 COVID-19 patients for about two to three months, starting from their time of diagnosis; about 70% of these patients had been hospitalized for COVID-19. The goal of the research was to spot common traits among the patients who went on to develop long COVID, or “post-acute sequelae of COVID-19” (PASC) — a medical term that refers to the effects that SARS-CoV-2 can have on the body after the initial COVID-19 infection passes.

The study participants provided blood and nasal swab samples at diagnosis, during their COVID-19 infections and then several months later. At this last follow-up, the patients completed a survey about symptoms related to long COVID, including cough, fatigue, shortness of breath, diarrhea, memory problems, difficulty concentrating and loss of taste and smell.

In all, about 37% of the patients reported three or more long COVID symptoms at their last follow-up; 24% reported one or two symptoms; and the remaining 39% reported no symptoms, Jim Heath, the principal investigator of the study and president of the Institute for Systems Biology, told The New York Times. In general, the respiratory viral symptoms were most common, followed by neurological symptoms, loss of taste and smell, and gastrointestinal symptoms, in that order, the researchers reported.

In the group with three or more long COVID symptoms, 95% exhibited at least one of the four newly-identified risk factors, Heath told The New York Times. The four risk factors were linked to long COVID regardless

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of whether a patient's initial infection was severe or mild. The team corroborated some of these findings by analyzing blood from an independent group of 100 post-acute COVID-19 patients, most of whom initially had mild infections.

Antibodies and GI and respiratory symptoms

Among the most notable of these risk factors were autoantibodies, which the team spotted in patients' blood samples. They specifically screened for six autoantibodies and found that the different antibodies appeared linked to different long COVID symptoms.

For example, the presence of one autoantibody, called anti-IFN- α 2, at the time of diagnosis forecasted respiratory symptoms of long COVID. The anti-IFN- α 2 antibody latches onto a chemical messenger called interferon alpha-2 that helps direct the activity of specific immune cells. The presence of anti-IFN- α 2 antibodies may cause these immune cells to malfunction and also boost the production of inflammatory molecules in the body, the study authors wrote.

Related: [11 surprising facts about the immune system](#)

In addition to anti-IFN- α 2, the researchers screened for five additional autoantibodies, called antinuclear antibodies, which bind to proteins in the cell's nucleus.

These five antibodies have been linked to various autoimmune disorders, including lupus and rheumatoid arthritis, but whether they directly damage cells or are just a marker of disease is unclear, he said. «There's not good evidence that they're pathogenic in and of themselves.»

In the new study, the antinuclear antibodies were linked to respiratory symptoms and some gastrointestinal symptoms of long COVID, the team reported.

Antibodies and neurological symptoms

By contrast, "neurological PASC is not significantly associated with these six autoantibodies that we measured," Su said.

Instead, neurological symptoms seemed linked to antibodies that target the coronavirus itself. These antibodies, which target the virus's so-called nucleocapsid, appear in high quantities after infection, once the long COVID symptoms have set in, the team found. Because these coronavirus-targeting antibodies appear later on, rather than around the time of

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diagnosis, they wouldn't necessarily be useful for predicting neurological long COVID symptoms ahead of time.

This antibody data hints that there may be different mechanisms driving the various subtypes of long COVID, Utz said. In the upcoming RECOVER Initiative, "we'll be able to look at thousands of patients," to see if that is borne out, he said.

Epstein-Barr and cognitive problems

EBV cropped up as another major risk factor for long COVID, the researchers reported.

An estimated 90% to 95% of people catch EBV by the time they reach adulthood, and after triggering an initial infection, the virus becomes dormant and hides out in the body's immune cells, according to the clinical resource UpToDate. But sometimes, if a person catches a different infection or is experiencing extreme stress, this dormant EBV can "reactivate," meaning it causes active infection once again.

Similar to the autoantibodies, reactivated EBV was tied to a specific subset of long COVID symptoms, according to the study. For example, patients with EBV in their blood at diagnosis showed a heightened chance of memory problems down the line, as well as fatigue and production of sputum, a thick mixture of saliva and mucus, in the lungs.

"We would normally not be able to detect EBV fragments in the blood; the detection of EBV fragments in the blood is a sign of their reactivation," Su said. Interestingly, EBV mostly appeared in patients' blood at the time of their COVID-19 diagnosis, after which blood levels of the virus swiftly decreased. "We do not have a clear answer regarding why this is," but it could be that, as the immune system rallies to battle the coronavirus, EBV gets a fleeting chance to reactivate and cause lasting damage, Su said.

Various research suggests that, in people who carry a specific set of genes, EBV infection can trigger lupus, according to a 2021 review in the journal Frontiers in Immunology. And earlier this month, scientists published compelling evidence that, in susceptible individuals, the virus may trigger multiple sclerosis, an autoimmune disease that affects the brain and spinal cord, in susceptible individuals, Live Science previously reported.

"We already know EBV plays an important role in lupus, and now, in multiple sclerosis," Utz said. Now, the new study hints that EBV may also play a role in long COVID, and "I will not be surprised if it ends up

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being correct," he said. A small study, published in June 2021 in the journal *Pathogens*, also hinted that COVID-19 might awaken EBV in some patients and increase their risk of long COVID, and the new study seems to add to that evidence.

Diabetes and coronavirus RNA

About one-third of the study's long COVID patients had type 2 diabetes. In particular, those with this risk factor were more likely to experience fatigue, cough and other respiratory viral long COVID symptoms.

In addition, about one-third of the long COVID patients carried high levels of SARS-CoV-2 genetic material, or RNA, in their blood at the time of diagnosis, and were likelier to experience memory-related long COVID symptoms.

The viral load finding suggests long COVID could potentially be prevented — or at least made less severe — in these patients if their viral loads can be reigned in with antiviral medications.

"The quicker one can eliminate the virus, the less likelihood of developing persistent virus or autoimmunity, which may drive long COVID," Su said. But given that long COVID can strike those with both mild and severe COVID-19 infections, it's unclear whether aggressive antiviral treatment would help all patients, Utz noted.

Other risk factors

Apart from the four main risk factors for long COVID, the new study also suggests that people with respiratory symptoms of long COVID have unusually low levels of the stress hormone cortisol in their blood. And those with neurological symptoms carry unusually high blood levels of proteins thought to reflect dysruption in the circadian sleep/wake cycle.

These findings may hint at treatments for long COVID, and in fact, cortisol replacement therapy is already being tested in long COVID patients, Su said. But ultimately, the only way to know if these approaches work, and for which subtypes of long COVID, is through clinical trials, Utz said.

Again, the new study is only a starting point, and it has several limitations. "Our study focused on PASC at 2 [to] 3 months post onset of COVID-19, and thus cannot discern which patients will develop much longer term chronic PASC," Su said. To better understand bouts of long COVID that drag on for four months or longer, future studies will need to follow COVID-19 patients for longer periods of time, he said.

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In addition, scientists will likely need to perform animal studies to understand why and how the identified risk factors lead to different forms of PASC, he said. And future studies will also need to address whether the different SARS-CoV-2 variants, from alpha to omicron, at all "alter the landscape of PASC experienced by patients," he noted.

Live Science, 2 February 2022

<https://www.livescience.com/>

States will weigh more than 210 bills on toxic "forever chemicals" in 2022

2022-02-04

Protecting people from exposure to toxic "forever chemicals" will be a top priority for new state regulations throughout the U.S. in 2022, according to a new analysis.

The analysis, published by the *Safer States* network, found that at least 32 states will consider more than 210 bills related to PFAS (per- and polyfluoroalkyl substances), making regulation of the chemicals one of the most prevalent issues in state policy making this year.

PFAS are a class of more than 9,000 compounds with similar properties. They're used in everything from clothing and carpeting to nonstick pots and pans, furniture, cosmetics and personal care products, and food packaging containers. PFAS don't readily break down once they're in the environment, so they accumulate in human bodies over time. Exposure to PFAS is linked to cancer, thyroid disease, high cholesterol, pregnancy-induced hypertension, asthma, and ulcerative colitis.

Testing has found PFAS in everything from chocolate cake and leafy greens to yoga pants and sports bras, makeup, and drinking water throughout the country.

"State legislatures recognize the severity of the toxic PFAS crisis we're facing and they're taking action," said Sarah Doll, national director of Safer States, in a statement. "States continue to lead the way in addressing these serious problems with urgency and innovative solutions."

States step up on PFAS

The U.S. Environmental Protection Agency has promised to regulate PFAS more strictly at the federal level. Efforts to do so are underway, but many

At least 32 states are considering laws that would ban or restrict PFAS, including their use in personal care products, clothing, and food packaging.

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health advocates say the process is moving too slowly. In the meantime, states are taking action to protect residents from harmful exposures.

The 32 states considering policies related to PFAS in 2022 include Alaska, Arizona, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Vermont, Virginia, Washington, West Virginia, and Wisconsin.

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According to the Safer States analysis:

At least 19 states will consider policies to regulate the use of PFAS, like restricting their use when it's avoidable, requiring disclosures when the chemicals are found in consumer goods, or restricting their use in specific categories like cosmetics, textiles, and food packaging (AK, CA, CO, HI, IA, IL, MA, MD, MI, MN, NH, NC, NJ, NY, PA, RI, VT, WA, and WI).

At least 17 states will consider policies related to PFAS cleanup, management, and accountability, such as designating the chemicals as hazardous, restricting their disposal, or allocating resources toward cleanup (AK, CA, FL, IL, IN, MA, ME, MD, MI, MN, NH, NC, OK, RI, VT, WA, and WI).

At least 19 states will consider legislation related to PFAS in drinking water, groundwater, or soil (AK, AZ, CT, FL, IA, IN, KY, ME, MN, NC, NH, NY, OH, RI, SC, VA, VT, WV, and WI).

At least three states will consider policies that ban PFAS in products labeled as recyclable (HI, MD, and NJ)

At least 6 states will consider policies that strengthen existing safe chemical policies for cosmetics or children's products (CA, MA, MI, NY, VT, and WA)

"In Michigan, PFAS and other 'forever chemicals' have impacted my community for decades," said Michigan State Senator Winnie Brinks (D-Grand Rapids) in a statement. "We've made significant strides in assessing the scope of the problem statewide and filtering PFAS out of drinking water."

"However, there's still so much to be done to stop contamination at its source, to require businesses to find alternatives to these harmful chemicals, and to create fair timeframes during which people who've

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been harmed can seek justice," Brinks added. "We also need stronger laws that send a message to corporate polluters that profits never come before public health."

PFAS in consumer goods

The analysis comes on the heels of novel testing from EHN.org and wellness community Mamavation that found evidence of PFAS in makeup, sports bras, and yoga pants and leggings.

And just last month the non-profit Toxic-Free Future found that almost three-quarters of 47 pieces of outdoor apparel, bedding, and kitchen linens that were marketed as stain- or water-resistant contain one or more PFAS.

"I've seen first-hand how the market is impacted by state policies on toxic chemicals," said Mike Schade, director of Toxic-Free Future's Mind the Store program, in a statement. "It's wise for retailers to get ahead of the curve and mitigate potential risks by taking action right away."

Banner photo: "In Michigan, PFAS and other 'forever chemicals' have impacted my community for decades," said Michigan State Senator Winnie Brinks (D-Grand Rapids), pictured here speaking about PFAS in drinking water in 2018. (Credit: Michigan House Democrats)

Environmental Health News, 4 February 2022

<https://www.ehn.org/>

SORRY EVERYBODY, BUT ALCOHOL "DIRECTLY CAUSES" CANCER

2022-02-03

According to a newly published genetic study, alcohol consumption directly causes several types of cancer. And the researchers behind the findings report this direct link between alcohol consumption and cancer remains consistent regardless of adjustments for diet, smoking, an inactive lifestyle or other factors that are known to contribute to cancer risk.

DIRECT LINK BETWEEN ALCOHOL & CANCER PREVIOUSLY UNPROVEN

Numerous studies have shown a general correlation between alcohol consumption and certain types of cancer. These typically include head, neck, liver, colon, and esophageal cancers. However, previous research could not completely rule out other causes that may be more prevalent in

DIRECT LINK BETWEEN ALCOHOL & CANCER PREVIOUSLY UNPROVEN

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high alcohol consumption individuals, including smoking, poor diet, or an inactive lifestyle.

Now, a team of researchers from Oxford Population Health, in conjunction with Peking University and the Chinese Academy of Medical Sciences, Beijing, have used a genetic study to strip away those other lifestyle influences and isolate the cancer-causing effect of alcohol consumption.

ALCOHOL DIRECTLY CAUSES SEVERAL TYPES OF CANCER

To conduct their study, the teams collected genetic samples from 150,000 Chinese participants, 60,000 of which were men and 90,000 of which were women. Each genetic sample was tested for a pair of alleles called ALDH2 and ADH1B that causes a portion of the East Asian Chinese population to have trouble processing alcohol, resulting in less consumption. According to a [press release](#) announcing the new study, "These mutations both disrupt the functioning of enzymes involved in alcohol detoxification, causing the toxic compound acetaldehyde, a Group I carcinogen, to accumulate in the blood."

All participants were asked to complete a questionnaire about their alcohol consumption, including women, who the study notes rarely drink in China (approximately 2%). Researchers then tracked those same patients for an average of 11 years using insurance reporting and death register data, and during that period, approximately 4,500 patients (7.4%) got cancer.

"Overall, men who carried two copies of the low-alcohol tolerability allele for ALDH2 drank very little alcohol," the press release notes, "and had a 14% lower risk of developing any cancer and a 31% lower risk of developing cancers that have previously been linked to alcohol."

The study corrected for other risk factors, isolating the consumption of alcohol from other lifestyle influences, leading to the study's stunning conclusion.

"These findings indicate that alcohol directly causes several types of cancer," said lead researcher Dr. Pek Kei (Becky) Im from Oxford Population Health.

Surprisingly, the men who carried at least one allele for alcohol intolerance but drank anyway were even more likely to get cancer than any other group, suggesting that the accumulation of acetaldehyde in these people may directly increase their cancer risk.

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"These risks may be increased further in people with inherited low alcohol tolerability who cannot properly metabolise alcohol," explained Dr. Im.

RAPIDLY DEVELOPING COUNTRIES SEEING INCREASE IN ALCOHOL CONSUMPTION

With their [results published](#) in the International Journal on Cancer, the authors behind the findings feel their work is particularly important in rapidly developing countries like China where researchers are seeing an overall increase in alcohol consumption.

"Our study reinforces the need to lower population levels of alcohol consumption for cancer prevention, especially in China where alcohol consumption is increasing despite the low alcohol tolerability among a large subset of the population," said senior researcher Dr. Iona Millwood from Oxford Population Health.

The Debrief, 3 February 2022

<https://thedebrief.org/>>

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Could Crispr Flip the Switch on Insects' Resistance to Pesticides?

2022-02-02

WHILE THE COVID-19 pandemic raged across the world in 2020, another disease was quietly infecting more than 220 million people on the continent of Africa: malaria. That year, the disease led to more than 600,000 deaths, most of them children. Caused by the parasite Plasmodium, the illness is spread through the bites of infected female Anopheles mosquitoes.

Insecticide-treated bed nets and indoor spraying have long been some of the most effective strategies for combating the disease. But decades of using these chemicals has lessened their potency.

It happens like this: Insecticides kill off most of the mosquitoes in an area. But a small number may survive because something about their genetic makeup makes them unaffected by the pesticide. Mosquitoes within that small population mate with each other and pass on their genes to their offspring, breeding more resistant mosquitoes. In some cases, resistance has built up just a few years after the introduction of an insecticide. It makes fighting deadly mosquitoes a constant game of whack-a-mole.

Insecticides remain the frontline in fighting malaria, because interventions like building mosquito-resistant housing are still experimental, and the effort to develop a vaccine has taken decades. Last summer the World Health Organization recommended Mosquirix, the first anti-parasitic vaccine, for African children under age 5, but it is only 30 percent effective at preventing serious disease, and will take many years to achieve approval and distribution among individual nations.

Researchers at UC San Diego and the Tata Institute for Genetics and Society in India have developed a potential way to fight back: Using Crispr gene editing, they replaced an insecticide-resistant gene in fruit flies with the normal form of the gene and propagated the change through insects in the lab. The approach, known as a gene drive, is described in a January 12 paper in Nature Communications, and the team believes it can be translated into mosquitoes.

"This technology I think offers a solution to the conundrum we're facing now, which is that there hasn't been a new category of insecticides developed for over 30 years," says Ethan Bier, professor of cell and developmental biology at UC San Diego and senior author of the paper. "If

Many insects, like the mosquitoes that spread malaria, have evolved a tolerance to chemical sprays. What if we could reboot their genes?

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you can go on using the ones you've got by re-sensitizing the mosquitoes to those, I think that would be an enormous benefit."

A gene drive is a type of technology that overrules the laws of heredity to spread a trait through a population more quickly than it would happen naturally, forcing that gene into a population's offspring. In this case, the change essentially reboots the gene pool to what it was before the insects evolved resistance to a particular pesticide.

The group's gene drive uses a molecule called a guide RNA that directs the Crispr system to remove the undesired variant of a gene—in this case, an insecticide-resistant mutation called kdr. When one parent transmits its genetic information to their offspring, a protein called Cas9 binds to the guide RNA, cuts out the mutated gene, and replaces it with the normal variant from the other parent. The normal variant is then copied and all the offspring inherit it.

The team first tried the process on fruit flies because they have a similar maturation time as mosquitoes, plus the researchers had already built gene-editing tools specific to fruit flies for previous experiments. They started with a population of flies in which 83 percent had the resistant variant and 17 percent had the normal version. In 10 generations, their gene drive flipped that ratio so that 17 percent were resistant and 83 percent were not. Fruit flies and mosquitoes each have a life cycle of about two weeks, so it would take several months to re-sensitize an entire insect population to pesticides.

Bier's team thinks the strategy could achieve a high degree of pest control while using far less insecticide. Other scientists working on gene drives want to use the technology to eliminate the use of pesticides altogether. One tack has been to genetically engineer the mosquitoes to kill the malaria parasite that they host. Another has focused on eradicating mosquitoes themselves: By using a gene drive to render males or females infertile, you could conceivably crash an entire population of mosquitoes.

Lab tests of gene drives have shown that it's possible to spread a desired genetic trait through several generations. But studies have also found that resistance to gene drives can emerge because some mosquitoes don't inherit the desired trait. In the wild, resistance is almost certain to occur, meaning that gene drives would probably still leave behind some mosquitoes that could bite humans and transmit disease.

Fredros Okumu, a parasitologist and entomologist who serves as director of science at the Ifakara Health Institute in Tanzania, says the type of gene

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drive tested by Bier's team could be used as a followup to one of these other approaches by making the leftover population easier to target with pesticides. Using both types of gene drives could "counter any weaknesses of either method alone," he says.

But insecticide resistance in the wild is complex. It can arise from dozens of genetic mutations. Okumu says that, for this strategy to work, scientists would have to know the precise genetic mutation that's causing resistance in a population of insects. Across Africa, many *Anopheles* mosquitoes are resistant to a class of insecticides called pyrethroids, which includes DDT.

"A system like this would be best only in areas where certain individual gene mutations are directly linked to observable resistance features," he says. "Still, I am personally very excited to see this."

As history has shown, mosquitoes are not easy to control in the wild. Take the *Aedes aegypti* mosquito, which transmits dengue, chikungunya, yellow fever, and Zika viruses. The pest is widespread throughout the western hemisphere, ranging from the mid-Atlantic region of the United States all the way to South America. But it wasn't always so pervasive. It arrived in the New World some 500 years ago on European slave ships that brought the insect from its native West Africa.

By the 1950s and 1960s, *Aedes aegypti* was virtually wiped out in Latin America after aggressive spraying of DDT. The campaigns were so successful that mosquito control efforts dwindled. But eventually, *Aedes aegypti* reappeared.

Bier and other scientists agree that one application of a gene drive is unlikely to work for the long term. Even if you could wipe out mosquitoes in one area, *Aedes aegypti*'s journey shows us that the pest can travel halfway around the world, pop up in a new place, and establish a new population. A gene drive like the one Bier's team developed might need to be applied seasonally, especially if multiple resistant genes are present within a population or new ones arise.

"This is no silver bullet," Bier says. "You never win when you try to play the evolutionary game with insects." His team is now working on translating the fruit fly gene drive into lab mosquitoes.

George Annas, a professor of health law and ethics at Boston University, says any gene drive—whether it's the traditional kill-all version or Bier's resistance-reversing approach—will need broad public support from people living in that area before it can be tested outside a laboratory. And

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convincing the public to release genetically modified mosquitoes just to keep using insecticides, which come with a host of negative health and environmental effects, could be a hard sell.

"A lot of people think we shouldn't use insecticides at all," Annas says. "The idea of using heavy-duty genetic editing so that we can continue using insecticides isn't going to appeal to everyone."

Ethicists have long raised other concerns about the potential ecological effects of releasing gene drive technology into the wild, including worries about resistance boomeranging back again. Annas, who authored a code of ethics for gene drive research, wants to see researchers develop a mechanism to recall or stop a gene drive if something unexpected happens once it's released. "I'm not saying we're going to develop a super mosquito, but that's not out of the realm of possibility," he says. "A gene drive might make things worse and you certainly don't want to do that."

www.wirec.com, 2 February 2022

<https://www.wired.com/>>

Urban animals may get some dangerous gut microbes from humans

2022-01-27

Animals moving into the big city could be getting more than they bargained for. Gut microorganisms from humans in cities may be spilling over into urban wildlife, potentially putting the animals' health at risk.

Fecal samples from humans and animals around the world show that urban critters harbor microbial communities that have much more in common with those in urban humans than in rural people and wildlife, researchers report in a preliminary study posted January 6 at [bioRxiv.org](https://www.biorxiv.org). While previous research has found captive animals can acquire human microbes — some linked with gastrointestinal disorders, immune deficiencies and even stunted growth — this is the first time a humanizing effect on wildlife has been found in cities, and between humans and reptiles.

Many of the microbes that show up more often in industrialized human populations are appearing in urban wildlife populations, but they're completely missing from the rural populations, says Andrew Moeller, an evolutionary biologist at Cornell University.

Fecal samples suggest urban wildlife have picked up microorganisms from city-dwelling people

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Many animals harbor symbiotic communities of microbes, products of evolutionary history that play an important role in immunity and fitness (SN: 6/24/19). To see how the microbe communities in urban animals compared with those in humans, Moeller and his team analyzed 492 fecal samples taken from humans, coyotes and lizards in urban and rural locations as varied as Edmonton, Canada, and Amazonian villages in Venezuela. The team used genomic analysis to find the abundance of microbial DNA in each sample and then compared the microbial profiles between urban and rural hosts.

Urban lizards and coyotes had gut microbiome communities more similar to urban humans than rural humans or wildlife, the researchers found. Most notably, they discovered 18 lineages of bacteria in urban wildlife that did not appear in their rural counterparts.

The parallel changes in microorganisms seen in diverse animals from different locations are convincing patterns of urban-specific microbial changes, says Taichi Suzuki, an evolutionary biologist at the Max Planck Institute for Developmental Biology in Tübingen, Germany, who was not involved in the study. "A big question is the mechanism driving this pattern, which needs further investigation," he says.

Research has found the human gut to be a source of the new bacteria lineages found in the urban wildlife, so they probably picked them up from people somehow, Moeller says. Humans shed bacteria from our personal microbial clouds, as we go about daily life (SN: 9/30/15). "The simplest explanation would be that the animals are just cohabiting in that same space, and therefore picking up microbes in their environment," says Moeller. It could also be a product of an urban gastronomic lifestyle, eating humans' leftovers: some bacteria are associated with high-fat, high-protein diets typically eaten in cities.

The research is a nice primer but could benefit from taking account of local diets and pathologies, says Mark van der Giezen, a microbiologist at the University of Stavanger in Norway also not involved with this study. "Urbanization is a social phenomenon of very complex nature," he says.

<https://www.sciencenews.org/article/urban-animals-gut-microbe-humans>, 27 January 2022

<https://www.sciencenews.org/>>

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Lightning bolt breaks record for longest ever recorded

2022-02-02

Two storms in 2020 set two new records for lightning, the World Meteorological Organization (WMO) announced today (Feb. 1).

One record was for longest single bolt, a record captured by a flash of lightning that stretched for about 477 miles (168 kilometers) from Texas to Mississippi during a storm on April 29, 2020. That's about the same distance between New York City and Columbus, Ohio.

The second record was for longest-duration bolt, which went to a flash that lit up the sky for an impressive 17.1 seconds during a storm on June 18, 2020, over Uruguay and northern Argentina.

The bolt that broke the record for length beat out the previous record-holder, a 440-mile-long (709 km) bolt that occurred during a storm in southern Brazil in 2018. The previous record-holder for duration also occurred in northern Argentina and lasted 16.73 seconds. It happened in March 2019.

"It is likely that even greater extremes still exist, and that we will be able to observe them as lightning detection technology improves," Randall Cerveny, a professor of geography at Arizona State University and rapporteur of Weather and Climate Extremes for WMO, said in a statement.

Lightning observation is changing as technology gets better. Previous records were detected by ground-based instruments known as lightning mapping arrays. But new satellite observers are allowing researchers a bird's-eye view of storms over huge distances. The two new record-breaking bolts were recorded on instruments aboard the GOES-16 and GOES-17 satellites, which are operated by NASA and the National Oceanic and Atmospheric Administration (NOAA). Europe has a similar eye-in-the-sky, the Meteosat Third Generation Lightning Imager, and China has the FY-4 Lightning Mapping Imager.

"Now that we have a robust record of these monster flashes, we can begin to understand how they occur and appreciate the disproportionate impact that they have," said Michael J. Peterson, an atmospheric scientist at Los Alamos National Laboratory who led the reporting of the new records, published Feb. 1 in the Bulletin of the American Meteorological Society.

The megaflash stretched 477 miles.

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“There is still a lot that we do not know about these monsters,” Peterson said in the statement.

Live Science, 2 February 2022

<https://www.livescience.com/> >

Why signs of life on Mars remain so mysterious

2022-02-01

For scientists searching for alien lifeforms, the siren song of Mars is climbing toward a crescendo. Multiple recent observations made by rovers on the red planet could bear the signatures of microbes—a possible indication that Earth is not the only refuge for life in the solar system.

One exciting glimmer was announced earlier this month: NASA’s Curiosity rover observed a mixture of carbon isotopes in the rocks of Gale crater that, if seen on Earth, would be a sign of life. The rover has also witnessed both random and seasonal surges of methane, a gas on Earth that is predominantly produced biologically.

About 2,300 miles away in Jezero crater, NASA’s Perseverance rover has spied strange purple coatings on the crater floor’s rocks. These coatings are widespread and resemble desert varnishes on Earth that grow in the presence of microbes.

For now, though, scientists aren’t ready to conclude that our vermilion neighbor was once inhabited. Just about every alluring hint of biology could also be explained by some as-yet unfamiliar aspect of Mars’s geology or chemistry—there’s just so much we don’t know about how the planet works, and how nonliving phenomena could be masquerading as life’s fingerprints.

“This is an alien world that we’re looking at, and so who knows what we haven’t even thought of,” says Curiosity deputy project scientist Abigail Fraeman of NASA’s Jet Propulsion Laboratory.

Scientists say the next step in probing Mars for life is bringing bits of the planet back to labs on Earth, where the sharpest instruments available can search for answers to one of humanity’s oldest questions. The Perseverance rover is already busy collecting the first set of samples, which could contain evidence that microorganisms lived in Jezero crater billions of years ago.

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No matter the answer, it will tell us something profound about the origins of life on our own planet.

“So much of [the two planets’] ancient history is similar, and it’s so intriguing that in our planetary evolution, those pathways have diverged so greatly,” says astrobiologist Amy Williams of the University of Florida. “If there isn’t life on Mars, why not? What changed? What happened? Why wouldn’t it be there? And if it took hold, what happened to it?”

Is there life on Mars?

In our fantasies, Mars has almost always been inhabited—if not by aliens, then at least by our future selves. But spacecraft observations quickly snuffed out dreams of advanced civilizations, seasonally flourishing vegetation, or even benign, gelatinous vegetarians.

“We don’t have anything glowing, we don’t have anything saying hello, we had no ray-guns when we landed there,” says Andrew Steele of the Carnegie Institution for Science.

Instead, images from orbit and experiments conducted by NASA’s Viking landers on the planet’s surface made it clear that Mars was not a world awash in easily detectable life. “That kind of kicked a hole in Mars research for a very long time,” Steele says.

In 1996, scientists announced that a Martian meteorite recovered from Antarctica’s Allan Hills region appeared to contain microfossils—tiny, worm-shaped, mineralized signs that life had crawled across the planet’s surface some 4.1 billion years ago. Those observations were ambiguous and extremely divisive, provoking debates that persist to this day. But there was an upside.

“The Allan Hills controversy has really fueled so much of the astrobiology field,” says astrobiologist Kennda Lynch of the Lunar and Planetary Institute. “I feel so grateful to that rock, because it’s made us really, really think about what we know about life.”

A new era of Mars exploration began in 2012 when NASA’s six-wheeled Curiosity rover landed in Gale crater. Today, the 96-mile-wide gouge is home to a large mountain containing many layers of sediments that preserve a record of the Martian past. Curiosity’s primary goal is to search for signs of past habitability, such as water, organic compounds, and an energy source—the ingredients necessary for life as we know it.

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Finding evidence of water was easy; after all, scientists already suspected the crater had once been filled by a deep lake. Curiosity almost immediately identified a swath of rocks that can form only when water is present.

The rest hasn't been so simple.

Over the years, Curiosity has uncovered evidence in the crater for numerous organic molecules —the chemical building blocks for carbon-based lifeforms. And it has spotted signs of ancient hydrothermal activity, where heat and chemical compounds mixed with flowing water, creating possible energy sources.

The rover has also determined that methane gas in the crater rises and falls as the seasons change, and it has observed occasional, massive pulses of the gas, confirming Earth-based observations that have defied explanation for more than a decade. Such a fluctuation on Earth would be a strong sign of beings with active metabolisms.

However, none of these observations have so far been linked to biology, and there's always a chance that processes we don't fully understand are mimicking the signatures of life.

"Most carbon-related processes on Earth's surface are biological, so to try and change our mindset around and think about a world where that might not be true is really a challenge," says astrobiologist Christopher House of Pennsylvania State University. "Once you get out of the Earth-centric mindset, then you can start to think of these other ways in which Mars might behave."

The curious case of Martian carbon

Curiosity's weirdest, most tantalizing observation only emerged recently. In multiple rock samples from various locations in the crater, the rover found organic compounds containing odd ratios of carbon isotopes, or atoms of the same element that contain different numbers of neutrons in their nuclei.

On Earth, organisms prefer to use the lighter form of carbon in metabolic or photosynthetic reactions, leading to a skewed ratio in which the lighter form is much more abundant than the heavier form.

And in five locations in Gale Crater, scientists found the exact same thing: lighter carbon isotopes were much more abundant than their heavier cousins, relative to what scientists have seen in the Martian atmosphere

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and in meteorites. The observations resemble carbon ratios collected from Australia's Tumbiana formation, a 2.7-billion-year-old outcrop that contains the carbon signatures of ancient, methane-metabolizing microbes.

"These really depleted carbon isotope results are so intriguing. So compelling. On Earth, the only way you do this is with biology," Williams says.

But House, who led the analysis, says the story is far from clear. He and his colleagues offered three possible explanations for the imbalance.

The first is that the signature does indeed come from ancient microbes. Another possibility is that the solar system long ago sailed through an interstellar dust cloud with a peculiar carbon isotope ratio—such clouds are known to exist—and it left its traces on Mars. And a third possible explanation is that ultraviolet light interacting with Mars's carbon dioxide atmosphere produced the odd signature.

"We don't know the answer," House says. "It may be biological, and it may not be biological. All three explanations fit the data."

A mysterious coating on the rocks

NASA's Perseverance rover arrived at Jezero crater on Mars last year, and it's also on the hunt for signs of ancient life.

During its travels through Jezero, Perseverance spied numerous rocks with a purple, iron-rich coating. Purdue University's Bradley Garczynski, who is studying the coating, says it's unlike anything that rovers have spotted on Mars before—even though rocks with different coatings have been seen on other parts of the planet.

On Earth, such coatings are often observed in deserts, where conglomerates of rock-munching microbes thrive.

"They're really intriguing, and they're certainly on Earth of biological interest, so by translation they are then of great astrobiological interest to us when we see them forming on other worlds," Williams says.

Lynch, who studies terrestrial analogs of Martian environments, says it wouldn't be out of the question to find biosignatures in the Jezero rock varnishes. "Microbes do amazing things. They put coatings and varnishes on the rocks because they like to eat the rock," she says.

However, scientists have a lot more context about the environments on Earth in which such varnishes form, Lynch says, and that context is

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crucial for properly interpreting an observation. Even on our own planet, investigators need to rigorously evaluate whether such a material were produced by life or by some other process. That's a much tougher question to answer from afar.

"It's a wonderfully complicated and complex system that we're exploring on Mars," Fraeman says.

Ambiguity from another world

For now, definitive detection of life requires bringing pieces of Mars back to Earth, where scientists can use the most capable instruments available to scrutinize them. One of Perseverance's primary tasks is to identify and collect rock samples for a future spacecraft to send home.

"The samples we're collecting now, they're being very carefully selected," Fraeman says. "We know broadly the context that they're coming from. ... That's going to be key to pulling apart these big questions."

But even having chunks of Mars in the laboratory isn't a salve for ambiguity. Scientists are still arguing about what might or might not have lived in ALH84001, that chunk of ancient Martian crust that crashed into Antarctica some 13,000 years ago. Steele, who recently led a fresh analysis of the meteorite, has been studying the rock for 25 years.

"One of the reasons I kept looking at is: If it's not life, what is it?" he says.

Steele and his colleagues reported earlier this month that complex organics in ALH84001 had been crafted without life's input, and that ordinary chemical reactions that occur when subterranean fluids interact with rocks and minerals were to blame.

"Does that mean there is no Martian life in that meteorite? Well, no I can't prove that," Steele says. "If a Martian organism exists in there, it's not showing us something that is common to Earth organisms. It's something totally different, and I'm still on the lookout for it."

Might such geologic reactions be the source of Martian methane, or the organics that litter the planet, or the rock coatings in Jezero? It's completely plausible, astrobiologists say. Mars is another world, a place with exotic chemistry and landscapes that, even though they look vaguely familiar, are still otherworldly.

"Time and again, Mars has demonstrated that it is not Earth. It is not an ancient Earth frozen in time," Williams says. "It is its own, evolving planet,

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and the processes that are occurring there, some are still Earth-like, and some are very alien."

National Geographic, 1 February 2022

<https://www.nationalgeographic.com/> >

Will animal-to-human organ transplants overcome their complicated history?

2022-01-31

A 57-year-old Maryland man has now survived just over three weeks with the transplanted heart of a genetically engineered pig. His doctor has hailed the operation as a "breakthrough surgery" that could help solve the organ shortage crisis. But from a scientific standpoint, it's too early in the game to know how much it moves the ball.

The use of animal organs for humans is an idea with a long, dramatic and often disappointing history (SN: 11/4/95). There's an old saying about xenotransplantation, as the field is known, says Joe Leventhal, a surgeon who heads the kidney transplant program at Northwestern University Feinberg School of Medicine in Chicago. "It's just around the corner. The problem is, it's a very, very, very long corner."

But a rash of new experiments, including three involving pig kidneys transplanted into people being kept temporarily alive on ventilators, has provided tantalizing evidence that achieving the decades-old ambition may finally be in reach.

The recent human operations come after an extensive effort to develop genetically altered pigs with organs that might avoid abrupt rejection, along with further refining of drugs that suppress the immune system and boost survival. That said, the Maryland heart operation was a Hail Mary rescue attempt and not part of a clinical trial — the kind of carefully designed study that is ultimately needed to show whether pig organs can function in humans, and do so safely.

One case can provide some valuable information about how the body responds to the organ, says Karen Maschke, a bioethics scholar at the Hastings Center in Garrison, N.Y., who is editor of *Ethics & Human Research*. "You may find stuff that you didn't expect to find," she says.

But a single snapshot of data doesn't have enough context to draw conclusions, especially when it involves a gravely ill patient and brand-new

A 'breakthrough' heart surgery earned acclaim, but it's not clear how long the organ will work

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technology. Without a study comparing several carefully selected patients, it's hard to know whether one individual's experience is typical.

Yet the latest flurry of pig-to-human transplant experiments could help open the door to the kinds of clinical trials that researchers want. That's the only way to significantly advance the science, says heart surgeon David Cooper of Massachusetts General Hospital in Boston, who has long researched the idea of xenotransplantation. "We'll learn much more if we are doing clinical cases than if we are staying in the laboratory."

High on the hog

If clinical trials ultimately prove successful, animals could help ease a critical shortage of donor organs. Of the more than 106,000 Americans waiting for a transplant, around 90,000 need a kidney. Many will die before one is available.

Doctors have previously turned to animal organs in bold, headline-grabbing endeavors. Famed Houston heart surgeon Denton Cooley transplanted a sheep heart as a desperate move to save a dying man in the 1960s; the man's body quickly rejected the organ.

One of the most high-profile tries at xenotransplantation occurred in 1984 when doctors at Loma Linda University Medical Center in California sewed a baboon heart into a 2-week-old baby born with a fatal cardiac defect (SN: 11/3/84). Baby Fae, as she was known, lived for 21 days and her surgery left a wake of controversy. Some medical ethicists called the operation a "bestly business" that lacked moral clarity. Scientists "beat a hasty retreat back to the laboratory," according to a 1995 report in the *Journal of the American Medical Association*.

More recently, scientists have focused on pigs, largely because porcine organs are about the size of adult humans', and the animals are already raised on an industrial scale. Still, the feasibility of the idea was thrown into doubt with the discovery in the 1980s that pig cells are coated with a type of sugar molecule, called alpha-gal, that strongly triggers the human immune system.

The field also experienced a setback with the discovery in the 1990s that the swine genome contains embedded viruses, snippets of viral genetic code woven into pigs' genetic instruction books. (It's not just a pig trait; these kinds of viral genes make up an estimated 8 percent of the human genome too.) The viruses, called porcine endogenous retroviruses, don't

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bother pigs but might cause problems after suddenly finding themselves in another species.

In the early 2000s, researchers reported the creation of genetically modified pigs lacking alpha-gal, making them theoretically more compatible with the human immune system than a hog straight from the farm. That announcement set off attempts to raise alpha-gal-free animals, most notably in the United States by Revivicor, a company owned by United Therapeutics, based in Blacksburg, Va. Then, in 2020, the possibility of pig-to-human transplants took a giant leap forward, when, for the first time, the U.S. Food and Drug Administration approved Revivicor pigs for human use.

Xenotransplantation also got a boon from CRISPR/Cas9 gene-editing technology and its remarkable ability to snip genes at will. Using CRISPR, scientists can trim the unwanted viral genes from pigs (SN: 8/10/17). "Gene editing with CRISPR has just really helped accelerate the field in sort of a warp drive," Leventhal says.

In recent experiments, pig kidneys and hearts have been successfully transplanted into baboons. Though the baboons died within days in early xenotransplantation attempts, researchers reported in 2018 that transplanted pig hearts kept beating in the chests of two baboons for about six months, a record at the time (SN: 12/5/18). Other similar experiments have replicated that survival time.

Then, in October 2021, scientists from NYU Langone Health in New York City made the jump to humans: In a test, they grafted a Revivicor kidney onto a person who was clinically brain-dead and watched the organ function for 54 hours, presumably long enough to detect any signs of immediate rejection (SN: 10/22/21). Less than two months later, the same surgical team repeated the experiment. A third such transplant from researchers at the University of Alabama at Birmingham, this time into the abdomen of a man kept temporarily alive by a ventilator following a motorcycle accident, was described January 20 in the *American Journal of Transplantation*.

None of the kidneys transplanted in people appeared to provoke immediate immune rejection, and the organs even began to produce urine, doctors reported. Given the overwhelming need for kidneys, and proof-of-concept renal tests already done, most experts predicted that the first modern patient to get a xenotransplant would need a kidney.

Then came the unexpected news of David Bennett.

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'I want to live'

Bennett was suffering from acute heart failure and did not qualify for the human heart transplant list. On New Year's Eve, the FDA gave doctors from the University of Maryland Medical Center permission to transplant the pig heart through a special protocol, sometimes called compassionate use, that allows very sick people emergency access to experimental drugs or devices — either because the patient doesn't qualify for any study of the drugs or because no study exists. Bennett's new heart also came from a Revivacor pig.

In a statement issued by the hospital, Bennett said he consented to the experimental surgery because he was simply out of options. He was bedridden, and no hospital would offer him a heart transplant, at least in part because he had a history of not following medical advice. "It was either die or do this transplant," he said. "I want to live." The eight-hour operation was performed on January 7.

A little over three weeks later, Bennett is gaining strength, says Muhammad Mohiuddin, a surgeon who directs the cardiac xenotransplantation program at the hospital and who was part of the surgical team. Everyday accomplishments, like talking with the staff about football playoffs, are tiny victories.

"We are counting all these smaller wins and hope this heart will keep supporting him," Mohiuddin says. The heart is strong enough that the doctors have had to dampen its power because it was too much for Bennett's body, weakened from lying in bed for weeks. "We put a Ferrari engine in a 1960 car," Mohiuddin says.

Still, Cooper, from Massachusetts General, said he was surprised when he learned that the first living pig-to-human transplant patient received a heart, not a kidney. "What are they going to do if this graft slowly begins to fail?" he asks. "There's going to be a little bit of a problem."

"I thought it would be the kidney first. Because if that fails — say you get rejection that you didn't expect, or you get infection that you can't manage — you can take the kidney out, stop all the immunosuppressive therapy and put the patient back on dialysis." A heart transplant is not so reversible.

Cooper and surgeon Hidetaka Hara, who were at the University of Alabama at Birmingham together, had suggested that the first xenotransplant should be a step-by-step clinical trial with four patients

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waiting for a kidney. The trial would work like this: Three months after the first patient receives a transplant, perform the operation in a second patient if the first person isn't having complications. If those two are doing well, transplant a third pig kidney three months later, and a fourth three months after that, the pair laid out in September in EBioMedicine. "So over the course of a year," Cooper says, "you've followed up four patients and you can see whether they are all doing well or are there complications."

Starting a clinical trial with kidneys also makes sense, Cooper says, because the need is so much greater. Around 83 percent of the transplant waiting list are people who need kidneys; 3 percent need a heart.

That's why eGenesis, a company in Cambridge, Mass., is focusing its research efforts on kidneys. "It's where the dominant need is," says Mike Curtis, the company's president of research and development. eGenesis, which is raising gene-edited, immune-compatible pigs, hopes to begin a clinical trial of six to 10 patients with transplanted pig kidneys around 2024.

Mohiuddin says that the reason he performed a heart operation is simple: He's a cardiac surgeon, and the patient was dying. "My 30-year interest has been only in hearts," he says. His research team has approached the FDA for permission to do a clinical trial, he says, but the agency wants more consistent data from baboon studies first. "We hope to get that permission," he says. "This was just to save Mr. Bennett's life."

One and not done

Should Bennett check out of the hospital and go home, that high-profile milestone could serve a purpose beyond allowing him more time with his family: It could help persuade the FDA to green-light a larger, scientifically designed trial, Cooper says.

If Bennett continues doing well, doctors "may be able to get a handful of [heart] patients done over the next few months. And then they go back to the FDA and say, look, these patients generally did well. Now can we do a proper series, where we take patients on our own waiting list and do the transplants?"

Leventhal, the surgeon from Northwestern, has the same hope about approved clinical trials. "The only way that you're going to see whether these organs provide meaningful function over the long term in humans, in a way that would justify their use, is to transplant them into humans and follow them longer-term."

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Still, it remains to be seen whether that will occur under compassionate use, as Bennett received, or in formal studies. The FDA's expanded access provision was designed to help people obtain drugs and procedures that they couldn't normally get. "Whether it should have been used in the case of an organ is an interesting ethical and regulatory and policy question," Maschke, the bioethicist, says.

"One of the problems with going the route they did is that there are probably hundreds of heart patients in the country who are not on a waiting list because they're too sick," Maschke says. "Some of those folks may say, 'I'll never take an animal organ,' but some of them might say, 'Yes, I would take a pig heart. I want to do this too. Can you get me access?'"

But opening the floodgates could make it harder to find volunteers for clinical studies. And in some cases, it could backfire. That's what happened in the 1990s when doctors started offering women with advanced breast cancer massive doses of chemotherapy followed by bone marrow transplantation to restore their collapsed immune systems. Thousands of women received the experimental treatment — so many that scientists had trouble recruiting for studies. And when the scientific trials were finally done, the treatment showed no benefit.

That's why there's often a concern about moving too fast, "because you don't want to derail the science — and the science is incremental," Maschke says.

For now, pig-to-human transplantation has logistical issues that will help restrict its use. For one, the painstakingly engineered pigs are hard to come by. In addition to their rare genetic pedigree, they must be raised in sterile environments so they don't pick up any microbes that might be transferred to humans. Another possible hurdle: Animal rights groups have decried the idea of pigs as spare parts for humans as "cruel and dangerous," a sentiment that society will need to square with the urgent medical need.

But first, doctors need to know if xenotransplantation is even possible, or will once again end in failure. "What we don't know is, how long and how well will these organs work in patients?" Leventhal says. "The only way we're going to assess that is through transplanting them."

ScienceNews, 31 January 2022

<https://www.sciencenews.org> >

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Human spines on sticks found in 500-year-old graves in Peru

2022-02-03

Hundreds of years ago, Indigenous people in coastal Peru may have collected the scattered remains of their dead from desecrated graves and threaded reed posts through the spinal bones. Scientists recently counted nearly 200 of these bone-threaded posts in stone tombs in Peru's Chincha Valley, and they suspect that the practice arose as a means of reassembling remains after the Spanish had looted and desecrated Indigenous graves.

Archaeologists investigated 664 graves in a 15-square-mile (40 square kilometers) zone that contained 44 mortuary sites. They documented 192 examples of posts threaded with vertebrae.

The researchers then measured the amount of radioactive carbon in the bones and reed posts. Radioactive carbon accumulates when an organism is alive but decays to nitrogen at a constant rate once the organism is dead. So based on the amount of this carbon, the scientists could estimate when the posts were assembled.

Their analysis placed the vertebrae and posts between A.D. 1450 and 1650 — a time when the Inca Empire was crumbling and European colonizers were consolidating power, the researchers wrote in a new study. This was a period of upheaval and crisis in which Indigenous tombs were frequently desecrated by the Spanish, and Chincha people may have revisited looted tombs and threaded spinal bones on reeds in order to reconstruct disturbed burials, said lead study author Jacob Bongers, a senior research associate of archaeology with the Sainsbury Research Unit at the University of East Anglia in the United Kingdom.

"The fact that there's 192 of these and that they're widespread — we find these throughout the Chincha Valley — it means on one level that multiple groups of people coordinated and responded in a shared way, that this interesting practice was deemed the appropriate way of dealing with disturbed bodies of the dead," Bongers told Live Science.

Most of the vertebrae on posts were found in and around large and elaborate stone tombs, called chullpas, that typically held multiple burials; in fact, one chullpa contained remains from hundreds of people, Bongers said. The people who performed the burials were part of the Chincha Kingdom, "a wealthy, centralized society that dominated Chincha Valley during the Late Intermediate period, which is the period that precedes the Incan Empire," Bongers explained.

Some of the reed-threaded vertebrae date to nearly 600 years ago.

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The Chincha Kingdom once had a population numbering around 30,000, and it thrived from around A.D. 1000 to 1400, eventually merging with the Inca Empire toward the end of the 15th century. But after the Europeans arrived and brought famines and epidemics, Chincha numbers plummeted to just 979 heads of household in 1583, according to the study. Historic documents record accounts of Spaniards frequently looting Chincha graves across the valley, stealing gold and valuable artifacts, and destroying or desecrating remains.

For the new study, the researchers closely examined 79 bone-threaded posts, each of which represented a collection of spinal bones from an adult or from a child. Most posts held bones belonging to a single individual, but the spines were incomplete, with most of the bones disconnected and out of order. This suggested that the threading was not performed as a part of the original burial. Rather, someone gathered and threaded the spinal vertebrae after the bodies had decomposed — and perhaps after some of the bones were lost to looting, the study authors reported.

And because Andean cultures valued preserving the integrity and completeness of a dead body, the likeliest explanation is that Chincha people revisited looted graves and reconstructed the scattered remains in this way to try and restore some semblance of wholeness to remains that had been dispersed and desecrated.

“When you look at all data we gathered, all of that supports the model that these were made after these tombs had been looted,” Bongers said.

Ancient mortuary practices, such as this bone threading, provide valuable clues about how long-ago communities dealt with their dead, but they also shed light on how people defined their identities and culture through their relationships with the dead, Bongers told Live Science.

“Mortuary practices arguably are what make us human — this is one of the key distinguishing features of our species. So, by documenting mortuary practices, we’re learning diverse ways of how people showcased their humanity.”

The findings were published Feb. 2 in the journal Antiquity.

Live Science, 3 February 2022

<https://www.livescience.com/> >

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Americans tend to assume imaginary faces are male

2022-01-27

There may be a reason we see a man, rather than a maiden, in the moon. When people spot facelike patterns in inanimate objects, those faces are more likely to be perceived as male than female, researchers report in the Feb. 1 Proceedings of the National Academy of Sciences.

In experiments with over 3,800 U.S. adults recruited online, participants reviewed about 250 photos of illusory faces — in objects from potatoes to suitcases — and labeled each one as male, female or neutral. Faces were deemed male about four times as often as they were female. Both male and female participants showed that bias, with about 80 percent of participants labeling more images male than female. Only 3 percent judged more to be female than male. The remaining 17 percent of respondents were fairly evenhanded in their labels.

In follow-up experiments, participants did not show the same bias toward images of the same kinds of objects without illusory faces. That finding helped rule out the possibility that participants viewed something about the underlying objects as masculine or feminine. Computer models that scoured the illusory face photos for stereotypically masculine or feminine elements — such as more angular or curved features (SN: 6/29/01) — couldn’t explain the bias, either.

“There’s this asymmetry in our perception,” says study author Susan Wardle, a cognitive neuroscientist at the National Institutes of Health in Bethesda, Md. Given the most basic pattern of a face, as is seen in illusory faces, “we’re more likely to see it as male, and it requires additional features to see it as female,” Wardle says. She points to the fact that female emojis and Lego characters are often distinguished from their male counterparts by the addition of bigger lips, longer lashes or other feminizing features.

It’s not yet clear why people perceive the basic structure of a face as male by default, Wardle says. But in a more recent study, she and her colleagues found the same gender bias in grade school kids as young as about 5 — suggesting it arises early in life.

“I was not surprised that people would assign gender to illusory faces,” says Sheng He, a cognitive neuroscientist at the Chinese Academy of Sciences in Beijing who was not involved in the research. He was, however, surprised by the strength of the gender bias that Wardle’s team discovered

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and wonders whether people living in matriarchal societies would show the same — or perhaps the opposite — bias in their reading of faces.

ScienceNews, 27 January 2022

<https://www.sciencenews.org/>>

Scotland hopes to save wild salmon by planting millions of trees next to rivers

2022-02-02

Millions of trees are being planted beside Scotland's remotest rivers and streams to protect wild salmon from the worst effects of climate heating.

Fisheries scientists have found rivers and burns in the Highlands and uplands are already too warm in summer for wild Atlantic salmon as they head upstream to spawn, increasing the threat to the species' survival.

Fisheries on the River Dee in Aberdeenshire, one of the country's most famous salmon fishing rivers, have planted 250,000 saplings along key tributaries. They plan to plant a million in the Dee's catchment by 2035, including native rowan, aspen, Scots pine, birch, willow, hawthorn and juniper.

In 2018, the year Scotland recorded the lowest rod catch for salmon since records began, climatic changes meant water temperatures in 70% of salmon rivers were too warm for at least one day that summer. They exceeded 23C, a temperature that induces stress and behavioural change.

A coldwater species, Atlantic salmon prefer summer temperatures above 10C; at 33C, they cannot survive. Marine Scotland scientists found that only 35% of Scotland's rivers, which stretch for 64,000 miles (103,000km), have adequate tree cover.

Lorraine Hawkins, the river director for the Dee District Salmon Fishery Board, a statutory body, said: "These rivers and burns are the nursery grounds for young fish and it's the young fish which will be affected by summer temperatures – their feeding and growth rates are affected. If it gets hotter, we will see fish dying."

Fishery boards across Scotland have similar tree-planting programmes, to provide essential shade to lower water temperatures. Many will be fenced off to prevent the saplings from being eaten by deer. Hawkins said these projects improved the overall health and biodiversity of rivers across the

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uplands, increasing insect life, leaf fall, managing essential nutrients and flood control.

Alan Wells, the director of Fisheries Management Scotland, an industry body, said climate forecasts were clear that water temperatures would continue to climb, even if governments succeed in limiting climate heating to close to 1.5C.

"We've seen situations where the temperatures in our rivers are approaching critical levels for our salmon, temperatures that they can't tolerate," he said. "This will get worse. We need to grow trees now to create that cooling shade."

The dramatic decline in wild salmon numbers is blamed on numerous factors: climate change affecting food availability; weirs and other obstructions in rivers; predation by soaring seal populations; sea lice attracted by fish farms; bycatch by trawlers at sea and poor river quality. Wells said that while Scottish ministers were proposing new conservation strategies, he remained frustrated with the slow pace of change.

The Dee marked the start of its angling season on Tuesday by inviting two female anglers who won a fundraising competition last year to make the first cast, an annual ceremony at Banchory. Women are increasingly taking up the sport, Hawkins said, eroding the sport's traditional domination by men in solitary pursuit of a catch.

Camryn Stewart, 14, one of the first cast fishers, said she had been brought up fishing by her parents, Deirdre and Jim. The sport is targeting women and children as it strives to expand its participation and appeal. Stewart fishes with three other girls of her age and said she did not feel like a revolutionary.

"I have been surrounded by people who fish, and I've wanted to fish all my life," she said. "We need more people fishing, not just women and children. We gain so much from it. Just being outside and being in the wild. Even if you don't catch anything, you come back from the day fulfilled."

The Guardian, 2 February 2022

<https://www.theguardian.com/>>

Studies in mice show selenium increases the number of new neurons, and improves memory in old age

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Widely available supplement may explain brain boost from exercise

2022-02-03

A good workout doesn't just boost your mood—it also boosts the brain's ability to create new neurons. But exactly how this happens has puzzled researchers for years. "It's been a bit of a black box," says Tara Walker, a neuroscientist at the University of Queensland's Brain Institute.

Now, Walker and her colleagues think they have found a key: the chemical element selenium. During exercise, mice produce a protein containing selenium that helps their brains grow new neurons, the team reports today. Scientists may also be able to harness the element to help reverse cognitive decline due to old age and brain injury, the authors say.

It's a "fantastic" study, says Bárbara Cardoso, a nutritional biochemist at Monash University's Victorian Heart Institute. Her own research has shown selenium—which is found in Brazil nuts, grains, and some legumes—improves verbal fluency and the ability to copy drawings correctly in older adults. "We could start thinking about selenium as a strategy" to treat or prevent cognitive decline in those who cannot exercise or are more vulnerable to selenium deficiency, she says, such as older adults, and stroke and Alzheimer's disease patients.

In 1999, researchers reported that running stimulates the brain to make new neurons in the hippocampus, a region involved in learning and memory. But which molecules were released into the bloodstream to spark this "neurogenesis" remained unclear.

So 7 years ago, Walker and her colleagues screened the blood plasma of mice that had exercised on a running wheel in their cages for 4 days, versus mice that had no wheel. The team identified 38 proteins whose levels increased after the workout.

One in particular caught Walker's eye: selenoprotein P (SEPP1). This protein, which transports selenium to the brain and has antioxidant properties, more than doubled after the rodents worked out.

In the new study, Walker's team, which was not funded by the supplement industry, added either of two forms of selenium—sodium selenite (found as a salt in water and soil) or selenomethionine (found as an amino acid in the diet)—to a dish filled with cells that give rise to new neurons. In just 14 days, the number of these "neural precursor cells" doubled. When the researchers injected sodium selenite directly into the mice's brains for 7

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days, the number of neural precursor cells in the hippocampus tripled, they report in *Cell Metabolism*.

"I've been working on neurogenesis for almost 20 years ... and we've never seen anything like that before," Walker says.

Mice genetically engineered to lack SEPP1 or its receptor got no boost in neural precursor cells with exercise, the team found, confirming SEPP1 was key to making the new neurons.

"It's the first time a substance that is usually in the diet has been found to have such a relevant and clear effect in neurogenesis," says Juan Encinas, a neurobiologist at the Achucarro Basque Center for Neuroscience. But he says other blood proteins boosted by exercise may also be at play.

To find out whether selenium can help the aging brain, Walker's team added selenomethionine to the drinking water of 18-month-old mice (the equivalent of 60-year-old humans). After nearly 1 month, the number of new neurons in the rodents' hippocampi had doubled.

The selenium-treated mice also performed better than controls in two memory tasks that rely on this brain region. In the first one, the treated mice learned to avoid a place where they got a mild electric shock better than controls. In the second, the team placed the mice in a brightly lit table with 32 holes, one of which allowed the animals to escape to a dark chamber. (Mice instinctively avoid bright, open spaces.) Using markings on the table as cues, the treated mice learned to escape about twice as fast as controls.

Finally, the researchers investigated whether selenium could help reverse the cognitive deficits that result from brain injury. They injected a molecule into the mice's hippocampus to cause a stroke-like lesion that destroys neurons and hurts memory. The lesioned but treated mice performed just as well as normal mice on a suite of memory tasks. The untreated lesioned mice, on the other hand, failed to recognize objects as new, and they had a hard time remembering locations where they had received a shock the day before.

The recovery effects seemed dependent on the neurogenesis boost: In a mouse model where the scientists could "delete" newly formed neurons, the beneficial effects of selenium disappeared.

The new results are "another piece of the puzzle" of how exercise impacts neurogenesis and cognition, says Sandrine Thuret, a neuroscientist at King's College London who was not involved with the work. She notes that

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a recent study showed clusterin, a molecule that also activates SEPP1's receptor—LRP8—is also elevated in blood after physical activity in mice and humans, and boosts memory. "That makes this [new] paper even more exciting."

Selenium is a cheap and widely available supplement. But Cardoso cautions that the chemical is toxic in high doses, and people who have normal selenium levels are less likely to benefit from supplementation. Still, she says, these preliminary results open avenues for testing selenium compounds to treat stroke patients. "I'm keen to see future studies in humans to see if they find the same thing."

Science, 3 February 2022

<https://www.science.org/>>

Construction may have damaged 112 million-year-old dinosaur tracks in Utah

2022-02-03

A government-funded backhoe removing a wooden boardwalk has badly damaged a unique dinosaur trackway in Utah, witnesses say.

The boardwalk was built to protect the ancient footprints, according to the Bureau of Land Management, which denies that its backhoe messed up the tracks.

Visitors to the site last week reported the damage to the Mill Canyon Dinosaur Tracksite, about 20 miles (30 kilometers) north of Moab, saying the marks made by the heavy vehicle's treads clearly lay on top of many of the dinosaur tracks, some of which are at least 112 million years old.

The Moab field office of the U.S. Bureau of Land Management, which operates the site, was performing the work to replace the boardwalk, The Salt Lake Tribune reported.

A public BLM proposal from October 2021 shows the boardwalk was starting to warp and had become a «trip hazard.» It's not known when the construction work to replace the boardwalk started, but there was no public outcry until social media reports on Jan. 30.

The BLM proposal called for replacing the wooden boardwalk with a walkway made from concrete and metal that would "improve the safety of visitors," and witnesses said the backhoe had dismantled sections of the old boardwalk and piled them beside the dinosaur tracks.

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Utah's state paleontologist, Jim Kirkland, told Science magazine that he had visited the trackway on Sunday (Jan. 30) and that the damage appeared to be confined to the perimeter of the protected area. He said no paleontologists were involved at any stage. «They didn't talk to us,» he said. «This was a bureaucratic screw-up.»

The BLM's Moab office has now halted the construction work and says the backhoe did not cause any damage: "The Moab Field Office is working to improve safe public access with an updated boardwalk that is designed to protect the natural resources of this site," BLM officials said in a statement. "During that effort, heavy equipment is on location, but it is absolutely not used in the protected area."

Dinosaur trackway

The Mill Canyon dinosaur trackway was discovered in 2009, and the site opened to the public in 2013.

According to Science magazine, Mill Canyon is Utah's most significant dinosaur trackway; it includes more than 200 fossilized Cretaceous period dinosaur footprints made by at least 10 species of dinosaurs, including giant long-necked sauropods, tree-eating iguanodonts, armored stegosaurs, and ferocious, meat-eating allosaurs.

The site also has rare fossilized evidence of animal behavior, including ancient crocodiles sliding on their bellies and a dinosaur swimming on an ancient lake bottom.

Fragile fossils

According to The Salt Lake Tribune, scientists who had visited the site had warned that the dinosaur tracks there were extremely fragile.

"It's been known from the beginning that the track-bearing layer was hard but thin and brittle," Lee Shenton, president of the Utah Friends of Paleontology's Moab chapter, told the newspaper. "We had experts from China, Korea, Argentina, Spain, the U.K. and the U.S., and every one of them told us, 'Don't walk on this tracks layer any more than you absolutely have to because it will fracture under your weight.' You may not see the fractures, but the next time there's a freeze thaw, those fractures will open up, and the tracks will be destroyed."

The BLM will not do any more construction at the Mill Canyon trackway until the investigation has concluded.

The government agency denies its backhoe messed up the fragile dino tracks.

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The Center for Biological Diversity, a nonprofit group based in Tucson, Arizona, has issued a [cease and desist letter](#) alleging the backhoe caused the «destruction of irreplaceable paleontological resources.»

According to witnesses, the letter said, “BLM construction equipment ... had driven directly over the fossilized dinosaur tracks, permanently destroying as much as 30% of the site.”

The letter demands that the BLM in Utah “stop all activity” at the Mill Canyon trackway until the protection requirements of several federal laws are obeyed, including provisions of the Paleontological Resources Preservation Act, which states, “a person may not excavate, remove, damage or otherwise alter or deface ... any paleontological resources located on Federal land.”

Live Science, 3 February 2022

<https://website>

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