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ASIA PACIFIC

APVMA maintains continued high performance in 2021–22

2022-09-30

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has finished 2021–22 with continued high performance, finalising 97.0% of product, active and permit applications within timeframe.

In 2021–22, the APVMA finalised in timeframe:

- 98.9% of pesticide applications
- 99.5% of veterinary medicines applications
- 98.3% of active constituent applications.

The annual statistics for 2021–22 are the first annual statistics reported under the updated format for performance reporting.

The percentage of permit applications completed within timeframe was positive at 88.7% in 2021–22. The APVMA continued to dedicate additional resources to support the timely processing of emergency use permits in response to incursions such as varroa mite and Japanese encephalitis virus, and also for biosecurity preparedness, including foot-and-mouth disease.

In the year ahead, the APVMA will continue to focus its efforts on ensuring Australians have timely access to safe and effective agricultural chemical and veterinary medicine products that lead to improved animal health, support producers, and help facilitate Australia's response to emerging pests and diseases.

Read More

APVMA, 30-09-22

https://apvma.gov.au/

China | Public consultation on revision plans of 7 GB regulation, including "General rules for preparation of precautionary label for chemicals"

2022-09-29

MIIT has put 7 GB (mandatory national) regulations revision plans for public consultation.

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The 7 GB regulations are:

- General rules for preparation of precautionary label for chemicals (will repeal GB 15258-2009)
- Limits of radionuclides in building materials (will repeal GB 6566-2010)
- Limit of the water-soluble Chromium VI content for cement (will repeal GB 31893-2015)
- Lighters - Safety and quality (will repeal GB 25722-2010)
- Utility lighters - Safety and quality (will repeal GB 25723-2010)
- Fireworks and firecrackers raw material safety and quality (will repeal GB 19595-2004)
- Safety and quality of fireworks and firecrackers (will repeal GB 20208-2006)

Read More

Chemycal, 29-09-22

https://chemycal.com/news/5f954c99-db49-45c8-9228-8313cf1d6f1b/China__Public_consultation_on_revision_plans_of_7_GB_regulation_including_General_rules_for_preparation_of_precautionary_label_for_chemicals

Variation of Inventory listing following revocation of CBI approval - 27 September 2022

2022-09-27

The Executive Director varied the terms of the Inventory listing for the following chemicals because approval was revoked for the proper name of the industrial chemicals to be treated as confidential business information (CBI). The terms of the listings as varied are:

CAS Number	1226781-96-9
Chemical Name	2-Propenoic acid, 2-methyl-, butyl ester, polymers with N-[3-(dimethylamino)propyl]-2-methyl-2-propenamide, 2-hydroxymethylethyl-terminated hydrogenated polybutadiene methacrylate, lauryl methacrylate, Me methacrylate, myristyl methacrylate and styrene
Molecular Formula	Unspecified

CAS Number	1226781-96-9
Specific information requirements as varied	Obligations to provide information apply. You must tell us within 28 days if the circumstances of your importation or manufacture (introduction) are different to those in our assessment.
Listing date	19 September 2022
CAS Number	219607-67-7
Chemical Name	2-Propenoic acid, butyl ester, polymer with (chloromethyl) oxirane, ethenylbenzene and 4,4'-(1-methylethylidene)bis[phenol]
Molecular Formula	(C15H16O2.C8H8.C7H12O2.C3H5ClO)x
Specific information requirements as varied	Obligations to provide information apply. You must tell us within 28 days if the circumstances of your importation or manufacture (introduction) are different to those in our assessment.
Listing date	21 September 2022

Published date

27 September 2022

Read More

AICIS, 27-09-22

https://www.industrialchemicals.gov.au/news-and-notices/variation-inventory-listing-following-revocation-cbi-approval-27-september-2022

Department admits it has 'little information' on pesticide residue in Australian food

2022-09-30

Federal authorities have admitted they have "little information" about the extent of pesticide residues in Australian food or their potential environmental damage, a document seen by the Guardian shows.

The Department of Agriculture, Fisheries and Forestry called for tenders in May this year for a study to identify the gaps in Australia's data collection on pesticides.

The advertisement, published on Austender in May, says: "There is little data currently available to the department regarding human health or

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environmental fate of [agricultural and veterinary] chemicals in Australia in 'field' conditions."

Australia's regulation of agricultural and veterinary chemicals used in the production of food came under the spotlight this year in a UK parliamentary inquiry examining the UK-Australia free trade agreement.

Environmental groups expressed alarm that Australia permits the use of 70 agricultural chemicals banned or withdrawn from use in Europe because of concerns about their impact on health or the environment. Many have been banned for years.

In its report, the parliamentary committee noted the concerns of UK agri-food producers that the agreement increases UK market access for food produced in ways that would be illegal in Britain, making for unfair competition.

Read More

The Guardian, 30-09-22

https://www.theguardian.com/australia-news/2022/sep/30/department-admits-it-has-little-information-on-pesticide-residue-in-australian-food

AMERICA

Governor Newsom Signs Legislation to Improve Electric Vehicle Infrastructure into Law

2022-09-19

California Governor Gavin Newsom signed legislation into law to improve access to reliable EV chargers for California drivers. The EV Charging Reliability Transparency Act, sponsored by FLO and ChargerHelp!, will help policymakers and EV drivers understand the performance of California's EV infrastructure and highlight inequities in driver access to reliable stations.

"If we want consumers to buy EVs, they need to know they can depend on public charging stations. Unfortunately, this is an area of needed improvement for the industry as EVs become more mainstream," said Louis Tremblay, President and CEO of FLO. "Thanks to Governor Newsom and California lawmakers, the EV Charging Reliability Transparency Act will tackle this issue head on."

In a recent survey by Plug In America, over half of respondents cited issues accessing public charging infrastructure, with broken chargers cited as the most common issue. Additionally, the University of California, Berkeley found only 72.5% of fast chargers in the state's Bay Area were functional.

Authored by Assembly Majority Leader Eloise Reyes (D–San Bernardino) and Assembly Budget Committee Chair Phil Ting (D–San Francisco) the law requires the disclosure of reliability data for all publicly funded EV charging stations in California and encourages the state to set requirements to increase overall reliability throughout all communities.

Read More

Daily Journal, 19-09-22

https://www.djournal.com/news/nation-world/governor-newsom-signs-legislation-to-improve-electric-vehicle-infrastructure-into-law/article_248440d4-a2cd-58e4-9200-1e16ee388e1d.html

California passes bill banning PFAS in textiles

2022-09-15

The California State Assembly has announced the passing of its 'Safer Clothes and Textiles Act' which would ban the use of certain chemicals in new fabrics and textiles.

The law specifically targets per- and polyfluoroalkyl substances (PFAS) which have been proven by various studies to be toxic and can pose significant health risks, as noted by the Natural Resources Defence Council (NRDC).

The act will head to Governor Newsom, who the Assembly said is expected to sign it into law, meaning it would come into force from January 1, 2025.

If implemented, the bill would ban the manufacture, distribution, sale or offering for sale of any new textiles containing regulated PFAS.

In addition, it would also require manufacturers to use the least toxic alternative when removing PFAS from their textiles in order to comply.

Read More

Fashion United, 15-09-22

https://fashionunited.uk/news/business/california-passes-bill-banning-pfas-in-textiles/2022091565159

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Notice of Intent to List Chemical by the Labor Code Mechanism: Antimony (Trivalent Compounds)

2022-09-30

The California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA) intends to list antimony (trivalent compounds) as known to the state to cause cancer under the Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65).

This action is being proposed pursuant to the "Labor Code" listing mechanism.[2] OEHHA has determined that this substance meets the criteria for listing by this mechanism.

Background on Listing by the Labor Code mechanism

Health and Safety Code section 25249.8(a) incorporates California Labor Code section 6382(b)(1) into Proposition 65. The law requires that certain substances identified by the International Agency for Research on Cancer (IARC) be listed as known to cause cancer under Proposition 65. Labor Code section 6382(b)(1) refers to substances identified as human or animal carcinogens by IARC. OEHHA has adopted regulations concerning these listings in Title 27, Cal. Code of Regs., section 25904. As the lead agency for the implementation of Proposition 65, OEHHA evaluates whether a chemical's listing is required.

OEHHA's Determination

Antimony (trivalent compounds) meets the requirements for listing as known to the state to cause cancer for purposes of Proposition 65.

IARC has published on its website a list entitled "Agents Classified by the IARC Monographs, Volumes 1 - 132" (IARC, 2022). IARC concludes that antimony (trivalent compounds) is "probably carcinogenic to humans" (Group 2A) based on limited evidence for cancer in humans, sufficient evidence of carcinogenicity in experimental animals, and strong mechanistic evidence in human primary cells and in experimental systems (Karagas et al., 2022).

Read More

OEHHA, 30-09-22

https://oehha.ca.gov/proposition-65/crnr/notice-intent-list-chemical-labor-code-mechanism-antimony-trivalent-compounds

EUROPE

EU, US, Canada take first steps in the development of a global chemicals database

2022-09-30

The US, Canada and EU are to embark on a pilot project that will test a system for exchanging data on substances and help inform the potential development of a global database of information on chemicals led by the OECD.

Speaking at Chemical Watch's Regulatory Summit Europe, held on 26-27 September, Bob Diderich, head of the OECD's environmental health and safety division, said a pilot project has been agreed between North American countries and the EU that will test how the database and exchange of information could work internationally.

At its 'core' will be the EU's International Uniform Chemical Information Database (Iuclid). Iuclid is an IT system that allows organisations to record, store, maintain and exchange data on intrinsic and hazardous properties of chemicals, co-developed by the OECD and Echa.

Mr Diderich said that Iuclid uses the OECD's harmonised templates (OHTs), which are standard data formats for reporting information used for the risk assessment of chemicals. These have also been integrated into other countries' chemicals information systems.

Read More

Chemical Watch, 30-09-22

https://chemicalwatch.com/575850/oecd-to-work-with-eu-us-and-canada-to-develop-a-global-chemicals-database

Commission seeks views on the future European Critical Raw Materials Act

2022-09-30

Today, the Commission has launched a call for evidence and a public consultation in preparation of the European Critical Raw Materials Act, which was announced by President von der Leyen during her 2022 State of the Union Speech.

Interested parties are invited to provide comments and evidence and reply to targeted questions on the current problems faced along the

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critical raw materials supply chain within and outside of the EU and how to address them. The questions cover the different stages of the value chain, from extraction to processing and recycling. The Critical Raw Materials Act will notably aim to identify policy actions necessary for developing strategic projects to strengthen the EU supply chains while maintaining a sustainable level playing field.

This legislative act will be complemented with a Communication presenting other initiatives to facilitate the supply diversification, through actions with third countries, including trade, cooperation and industrial strategic agreements, which could take the form of partnerships, sectoral agreements or multilateral initiatives. Critical Raw Materials are essential for the deployment of the technologies that enable the green and digital transitions. For instance, rare earths are key components of the permanent magnets used to manufacture wind turbines, lithium or cobalt are used in battery manufacturing, polysilicon is used for semi-conductors.

The acceleration of the green and digital transitions will increase the European and global demand for those critical raw materials and the EU must ensure that it can secure the critical raw materials it will need in the future. Interested parties can provide their input over the next 8 weeks, until 25 November 2022.

Read More

European Commission, 30-09-22

https://single-market-economy.ec.europa.eu/news/commission-seeks-views-future-european-critical-raw-materials-act-2022-09-30_en

Commission acts to better protect people from asbestos and ensure an asbestos-free future

2022-09-28

Asbestos is a highly dangerous, cancer-causing substance that is still present in many of our buildings and is responsible for many avoidable deaths in the EU. Today, the Commission presents a comprehensive approach to better protect people and the environment from asbestos and ensure an asbestos-free future.

The package includes:

- A Communication on working towards an asbestos-free future, tackling asbestos in a comprehensive way, from improving diagnoses

and treatment of diseases caused by asbestos, to identification and safe removal and waste treatment of asbestos; and

- A proposal to amend the Asbestos at Work Directive to improve workers' protection by significantly lowering the occupational exposure limit to asbestos.

Although all forms of asbestos are banned in the EU since 2005, asbestos remains present in older buildings. It poses a health threat, particularly when materials containing asbestos are disturbed and fibres are released and inhaled, for instance during renovations.

As much as 78% of occupational cancers recognised in the Member States are related to asbestos. When inhaled, airborne asbestos fibres can lead, for example, to mesothelioma and lung cancer, with an average lag of 30 years between exposure and the first signs of disease.

Read More

European Commission, 28-09-22

https://ec.europa.eu/commission/presscorner/detail/en/ip_22_5679

ECHA Call for evidence on skin sensitisers in consumer mixtures

2022-09-29

This Call for Evidence issued by the Competent Authorities of Denmark, France, Germany, and Ireland is an opportunity for all sectors to provide information on the presence of skin sensitising substances in mixtures with consumer uses, including information on known safe uses. In addition, epidemiological data on allergic contact dermatitis and information on health costs are requested. This CfE allows stakeholders and contact points within relevant sectors to identify themselves for possible subsequent consultations. The information gathered will provide valuable input to assess any potential need for regulatory actions on skin sensitisers in consumer mixtures in order to prevent skin sensitisation and allergic contact dermatitis in the general population.

Moreover, this Call for Evidence is issued to assess (i) whether there are risks that are adequately controlled under specific conditions, and (ii) what impact additional regulatory risk management would have on society. The scope of the investigation comprises substances fulfilling the criteria for classification as skin sensitisers as defined by the CLP Regulation (Regulation (EC) 1272/2008) in mixtures marketed or available for consumers in the EU/EEA. Uses of substances in cosmetic products, as defined by Directive 76/768/EEC, are outside the scope of the investigation (according to the REACH Regulation, Article 67).

The objective of this Call for Evidence is to gather information on:

- the sectors, and type of uses/applications concerned,
- measures currently in place (e.g. changed formulation, reduction of concentration, specific packaging, conditions of use) to minimise consumer exposure,
- experience regarding substitution efforts, availability and costs of alternatives or reasons for non-substitution,
- the potency of the skin sensitising substances and their technical functions in the mixtures,
- on safe use of consumer products,
- epidemiology of allergic contact dermatitis and other health-related information including health costs,
- analytical methods to detect the presence of skin sensitising substances in mixtures.

For any clarifications, please contact the German Competent Authority: chemg (at) baua.bund.de

Read More

ECHA, 29-09-22

https://echa.europa.eu/calls-for-comments-and-evidence/-/substance-rev/70301/term

EC Opens Call for Evidence on a Proposal for a Basic Regulation for ECHA

2022-09-30

On September 12, 2022, the European Commission (EC) opened a call for evidence on a proposal for a basic regulation for the European Chemicals Agency (ECHA). According to the EC, this initiative aims to strengthen ECHA governance and adapt it to its future role, as well as streamline the working methods of ECHA bodies and make their financing more sustainable. Responses are due October 10, 2022. The EC plans to adopt a regulation in the second quarter of 2023.

Title X of the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation (No. 1907/2006) established ECHA and set out its composition, tasks, and powers, as well as its budget. Since then, ECHA has been entrusted with additional technical, scientific, and administrative tasks arising from other legislation and agreements signed with the EC (e.g., Service Level Agreement for the provision of opinions on occupational exposure limits (OEL)). One of the goals of the EC's ambitious Chemicals Strategy for Sustainability (CSS), published on October 14, 2020, is to simplify and consolidate the European Union (EU) regulatory framework on chemicals. To coordinate and simplify actions across EU chemical legislation, the CSS calls for the EC to take several actions, including proposing "to strengthen the governance of the European Chemicals Agency and increase the sustainability of its financing model."

According to the call for evidence, the legal framework of ECHA and its bodies, particularly the Committee for Risk Assessment (RAC), the Committee for Socio-economic Assessment (SEAC), and the Enforcement Forum, need to be clarified to enable ECHA to meet its future obligations and maintain its independence. The call for evidence notes that in the future, RAC will issue scientific opinions on chemical substances based on existing tasks and tasks deriving from initiatives under preparation.

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JD Supra, 30-09-22

https://www.jdsupra.com/legalnews/ec-opens-call-for-evidence-on-a-4279404/

QSAR Toolbox extension broadens possibilities for animal-free chemicals assessment

2022-09-29

The new add-on helps users to predict chemical properties, including endocrine activity, while avoiding testing on animals.

The OPERA extension contains models for predicting properties that are important for assessing chemical hazards. The extension can be used to screen chemical databases to identify substances that may cause endocrine disruption. It also helps users to estimate acute oral toxicity and other regulatory relevant properties.

Developed by the US National Institute of Environmental Health Sciences (NIEHS), OPERA can predict properties related to the absorption, distribution and metabolism of substances that can strengthen read-across justifications and facilitate the regulatory use of in vitro test results.

The extension can be downloaded for free from the QSAR Toolbox Repository.

Background

The OECD QSAR Toolbox supports animal-free chemical hazard assessment by making data available and offering predictive tools for data gaps. It is co-developed by ECHA and the Organisation for Economic Co-operation and Development (OECD) and has almost 30 000 users worldwide, including regulatory authorities.

Users can add extensions from the QSAR Toolbox Repository to expand its functionalities. The repository now offers more than 10 free extensions developed by authorities and private companies.

OPERA (Open (Quantitative) Structure-activity/property Relationship App) is an ongoing collaboration between NIEHS and the United States Environmental Protection Agency (US EPA). It provides robust models for predicting chemical properties that can be used for regulatory purposes.

REACH Update

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Read More

ECHA, 29-09-22

https://echa.europa.eu/-/qsar-toolbox-extension-broadens-possibilities-for-animal-free-chemicals-assessment

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Janet's Corner

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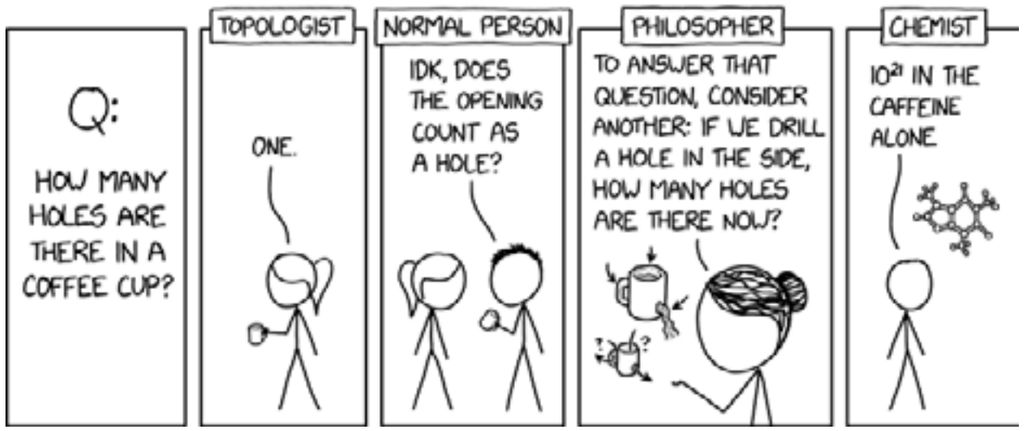
Coffee Cup Holes

2022-10-07



https://xkcd.com/2658/

1,4-Benzoquinone

2022-10-07

1,4-Benzoquinone, commonly known as para-quinone, is a chemical compound with the formula $C_6H_4O_2$. In a pure state, it forms bright-yellow crystals with a characteristic irritating odour, resembling that of chlorine, bleach, and hot plastic. This six-membered ring compound is the oxidised derivative of 1,4-hydroquinone. The molecule is multifunctional: it exhibits properties of a ketone, forming an oxime; an oxidant, forming the dihydroxy derivative; and an alkene, undergoing addition reactions, especially those typical for α,β-unsaturated ketones. 1,4-Benzoquinone is sensitive toward both strong mineral acids and alkali, which cause condensation and decomposition of the compound. [1]

USES [2]

1,4-Benzoquinone is used:

- In the manufacture of unsaturated polyesters as a polymerisation inhibitor;
- A raw material for production of hydroquinone;
- In a reaction with trialkylboranes to produce alkyl substituted hydroquinones;
- In the manufacture of fungicides;
- As an analytical reagent and an oxidizing agent in photography;
- In adhesive mixtures;
- In coal analysis (dehydrogenation of coal)
- In the pharmaceutical industry for production of cortisone & as an addition compound with barbiturates;
- In the polymer & resins industry;
- As a tanning agent for leather industry;
- In the manufacture of quinhydrone electrodes for use for pH determinations.

SOURCES AND ROUTES OF EXPOSURE

Sources of Exposure [3]

- Occupational exposure to 1,4-Benzoquinone may occur in the dye, textile, chemical, tanning, and cosmetic industries.

1,4-Benzoquinone, commonly known as para-quinone, is a chemical compound with the formula C6H4O2.

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- Inhalation exposure to 1,4-Benzoquinone may occur from tobacco smoke.

Routes of Exposure [4]

1,4-Benzoquinone can be absorbed into the body by inhalation and by ingestion.

HEALTH EFFECTS [3]

Acute Effects

- Acute exposure to high levels of 1,4-Benzoquinone, via inhalation in humans, is highly irritating to the eyes, resulting in discoloration of the conjunctiva and cornea, while dermal exposure causes dermatitis with skin discoloration and erythema.
- Animal studies have reported effects on the kidneys from exposure to 1,4-Benzoquinone.
- Tests involving acute exposure of rats have shown 1,4-Benzoquinone to have high acute toxicity from oral exposure.

Chronic Effects

- Chronic dermal contact to 1,4-Benzoquinone in humans may result in skin ulceration, while chronic inhalation exposure may result in visual disturbances.
- EPA has not established a Reference Concentration (RfC) or Reference Dose (RfD) for 1,4-Benzoquinone.

Reproductive/Developmental Effects

- No information is available on the reproductive or developmental effects of 1,4-Benzoquinone in humans or animals.

Cancer Risk

- No information is available on the carcinogenic effects of 1,4-Benzoquinone in humans.
- 1,4-Benzoquinone has been tested (in older animal studies) by dermal application, inhalation, and subcutaneous injection. However, the results are insufficient to evaluate the carcinogenicity of the compound.
- EPA has not classified 1,4-Benzoquinone for carcinogenicity.
- IARC has classified 1,4-Benzoquinone as a Group 3, not classifiable as to the carcinogenicity to humans.

SAFETY [5]

First Aid Measures

- 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 immediately.
- 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 and Explosion Information

- 1,4-Benzoquinone may be combustible at high temperature.
- Auto-ignition temperature is 560°C (1040°F)
- Dry chemical powder should be used to fight small fires
- For large fires, water spray, fog or foam should be used.
- 1,4-Benzoquinone in powder form, capable of creating a dust 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 1,4-Benzoquinone:

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

Personal protective equipment 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

United States [6]

OSHA: The United States Occupational Safety & Health Administration has set the following Permissible Exposure Limit (PEL) for 1,4-Benzoquinone:

- General Industry: 0.1 ppm, 0.4 mg/m3
- Construction Industry: 0.1 ppm, 0.4 mg/m3 TWA

ACGIH: The American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV)for 1,4-Benzoquinone of 0.1 ppm, 0.44 mg/m3 TWA

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NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL)for 1,4-Benzoquinone of 0.1 ppm TWA

Australia [7]

Safe Work Australia: Safe Work Australia has set a time weighted average concentration (TWA) for 1,4-Benzoquinone of 0.1 ppm, 0.44 mg/m3 for a 40-hour workweek.

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3. http://www3.epa.gov/airtoxics/hlthef/quinone.html
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6. https://www.osha.gov/dts/chemicalsampling/data/CH_265400.html
7. http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/772/Workplace-exposure-standards-airborne-contaminants.pdf

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Gossip

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Planetary Heist: Astronomers Discover That Stars Can Steal Planets

2022-09-24

Researchers at the University of Sheffield have proposed a new origin for Jupiter-like planets orbiting massive stars three times the mass of our Sun.

According to recent research, massive stars in the densely populated stellar nurseries where most stars are created may steal or capture planets the size of Jupiter.

University of Sheffield researchers have presented a new explanation for the newly found B-star Exoplanet Abundance STudy (BEAST) planets. These are Jupiter-like planets that are located far from massive stars—hundreds of times further than the distance between the Earth and the Sun.

Until recently, their development has been a mystery, since massive stars generate large amounts of ultraviolet radiation, which prevents planets from expanding to the size of Jupiter, our solar system's largest planet.

Dr. Emma Daffern-Powell, co-author of the study, from the University of Sheffield's Department of Physics and Astronomy states, "Our previous research has shown that in stellar nurseries stars can steal planets from other stars, or capture what we call 'free-floating' planets. We know that massive stars have more influence in these nurseries than Sun-like stars, and we found that these massive stars can capture or steal planets – which we call 'BEASTies.'"

She adds, "Essentially, this is a planetary heist. We used computer simulations to show that the theft or capture of these BEASTies occurs on average once in the first 10 million years of the evolution of a star-forming region."

Dr. Richard Parker, a lecturer in astrophysics in the University of Sheffield's Department of Physics and Astronomy explains: "The BEAST planets are a new addition to the myriad of exoplanetary systems, which display incredible diversity, from planetary systems around Sun-like stars that are very different to our Solar System to planets orbiting evolved or dead stars The BEAST collaboration has discovered at least two super-Jovian planets orbiting massive stars. Whilst planets can form around massive stars, it is hard to envisage gas giant planets like Jupiter and Saturn being able to form in such hostile environments, where radiation from the stars can evaporate the planets before they fully form."

According to recent research, massive stars in the densely populated stellar nurseries where most stars are created may steal or capture planets the size of Jupiter.

He continues, "However, our simulations show that these planets can be captured or stolen, on orbits very similar to those observed for the BEASTies. Our results lend further credence to the idea that planets on more distant orbits (more than 100 times the distance from Earth to Sun) may not be orbiting their parent star."

Sci Tech Daily, 24 September 2022

https://scitechdaily.com

Explaining the Most Baffling Quirk of COVID: Common Gene Variant Linked to Mortality

2022-09-24

It may be the most baffling quirk of COVID: While some infected individuals only have minor, flu-like symptoms, in others COVID-19 can spiral into severe disease, disability, and even death. A new research paper published on September 21 in the journal Nature may explain the genetic underpinnings of this dichotomy.

In their latest research, scientists showed that mice with gene variants previously linked to Alzheimer's disease were at a greater risk of dying when infected with SARS-CoV-2, the virus that causes COVID-19. In addition, a retrospective analysis indicates that patients with those same gene variants were more likely to have died of COVID throughout the pandemic. With 3% of the world population possessing these gene variants, the findings may have implications for hundreds of millions of individuals worldwide.

"It is clear that age, sex, and certain preconditions such as diabetes increase the risk of detrimental outcomes, but these factors don't fully explain the spectrum of COVID outcomes," says Sohail Tavazoie, M.D., Ph.D. He is the Leon Hess Professor, Howard Hughes Medical Institute Faculty Scholar and Head of the Meyer Laboratory of Systems Cancer Biology at The Rockefeller University. "This is the first time that we've seen such a common genetic variant associated with COVID mortality."

A closer look at APOE

In previous research, Tavazoie's lab studied a gene called APOE that plays a role in cancer metastasis. After discovering that the gene suppresses the spread of melanoma and regulates anti-tumor immune responses, he and his team began looking at its different forms, or alleles, more closely. Although, most people have a form called APOE3, 40% of the population

New research may explain why some people with COVID-19 only experience minor, flu-like symptoms and others have severe disease that can result in death.

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carries at least one copy of the APOE2 or APOE4 variant. People with APOE2 or APOE4 produce proteins that differ from APOE3 protein by one or two amino acids.

Just one or two amino acids make a difference. Notably, people with APOE4 are at greater risk of developing Alzheimer's and atherosclerosis. Also, Tavazoie and Benjamin Ostendorf, a postdoctoral fellow in his lab, have demonstrated that APOE4 and APOE2 impact the immune response against melanoma. As the COVID-19 pandemic progressed, Tavazoie and Ostendorf began to wonder whether APOE variants might impact COVID outcomes, as well. "We had looked only at non-infectious diseases," he says. "But what if APOE variants also made people vulnerable to an infectious agent, like SARS-CoV-2? Could they cause different immune responses against a virus?"

To investigate, Tavazoie and colleagues first exposed more than 300 mice engineered to carry human APOE to a mouse-adapted version of SARS-CoV-2 produced by colleagues Hans-Heinrich Hoffmann and Charles M. Rice. They discovered that mice with APOE4 and APOE2 were more likely to die than those with the more common APOE3 allele. "The results were striking," says Ostendorf, lead author on the study. "A difference in just one or two amino acids in the APOE gene was sufficient to cause major differences in the survival of mice exhibiting COVID."

In addition, mice with APOE2 and APOE4 had more virus replicating in their lungs and more signs of inflammation and tissue damage. At the cellular level, the scientists discovered that APOE3 appeared to reduce the amount of virus entering the cell, while animals with the other variants had less potent immune responses to the virus. "Taken together, these results suggest that the APOE genotype impacts COVID outcomes in two ways," Ostendorf says, "by modulating the immune response and by preventing SARS-CoV-2 from infecting cells."

Toward clinical practice

The lab next turned to retrospective human studies. In an analysis of 13,000 patients in the UK Biobank, the research team uncovered that individuals with two copies of either APOE4 or APOE2 were more likely to have died of COVID than those with two copies of APOE3. (Approximately 3% of individuals have two copies of APOE2 or APOE4, representing an estimated 230 million people worldwide.)

Tavazoie emphasizes that there is no evidence that the 40% of individuals carrying only one of these alleles are at increased risk. Furthermore, he

says those with two APOE2 or APOE4 alleles are likely at lower risk today than the data indicates. "Vaccination changes the picture," he explains. "Data in UK Biobank spans the length of the pandemic, and many of the individuals who died early on would likely have been protected had they been vaccinated."

Moving forward, Tavazoie hopes to see prospective studies on the link between APOE and distinct COVID outcomes. "We've taken the first step," he says. "But to be clinically useful, these results will need to be assessed in prospective human trials that test individuals for their APOE genotypes and account for the availability of vaccination, something that wasn't available early in the pandemic and would improve COVID outcomes across APOE genotypes."

If future research confirms a link between APOE and COVID outcomes, clinicians might recommend that individuals with APOE4 or APOE2 be prioritized for vaccinations, boosters, and antiviral therapies. Screening for APOE is fairly routine and inexpensive, and many individuals already know their APOE variants because commercial genetic tests such as 23andMe use it to gauge Alzheimer's risk. At the same time, Tavazoie cautions that screening for a gene variant linked to Alzheimer's is not without ethical hurdles, because many people would rather not know whether they are predisposed to an incurable neurodegenerative disease.

For his part, Tavazoie plans to also take a closer look at how APOE interacts with various biological systems. The link between APOE4, Alzheimer's, and COVID, for instance, raises the possibility that this gene may play a role in the neurocognitive complications that arise in some COVID patients. "We want to better understand the function of APOE by studying how it shapes the behavior of cells in these disparate contexts of cancer, dementia, and now viral infection," Tavazoie says.

Sci Tech Daily, 24 September 2022

https://scitechdaily.com

Fossil algae predates the origin of land plants and modern animals

2022-09-24

Palaeontologists have discovered an algae fossil in China, identifying it as a new genus and species called Protocodium sinense. The ancient fossil — 541m years old — predates the origin of land plants, giving scientists new insights into the early diversification of the plant kingdom.

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And interestingly the fossil is the first and oldest green algae from this era to be preserved in three dimensions, which has enabled scientists to investigate its internal structure with unprecedented accuracy.

They found that Protocodium appears almost identical to its close relative the modern Codium – a type of green algae found today in many seas – which pushes back the point in history that green algae and land plants shared a common ancestor.

The findings have been reported in a new study in BMC Biology.

"Protocodium" belongs to a known lineage of green algae and has a surprisingly modern architecture, showing that these algae were already well diversified before the end of the Ediacaran period," says co-author Cédric Aria, postdoctoral fellow in the Department of Ecology & Evolutionary Biology at the University of Toronto and based at the Royal Ontario Museum (ROM) in Canada.

"Its discovery touches the origin of the entire plant kingdom and puts a familiar name on the organisms that preceded the Cambrian explosion over half a billion years ago, when the world's first modern ecosystems emerged."

Green algae can photosynthesise, converting light and carbon dioxide into sugars and oxygen. They were therefore likely important foundations of Earth's early ecosystems, and the study suggests green algae were already established in the world's shallow waters, as carbon dioxide recyclers and oxygen producers, before the Cambrian explosion.

The Protocodium were discovered as part of the Gaojiashan biota, a significant group of exceptionally well-preserved fossils at the Dengying Formation in the southern Shaanxi Province in north-west China.

"We know that seaweed-like fossils are at least one billion-years-old," says first author Dr Shu Chai, postdoctoral researcher at Northwest University in Xi'an in Shaanxi Province. "But until now, flat, grainy two-dimensional preservation has made it challenging to recognise more than general morphological structures."

The whole fossil and its fine cellular details were preserved in three dimensions in a process called phosphatisation where the original organic material was replaced by phosphate, allowing researchers to use electron and X-ray microscopy to virtually slice the through the fossil to reveal its internal structures.

Paleontologists have identified a new genus and species of algae more than 500m years old.

Protocodium fossils are spherical and small (only about half a millimetre wide), with a surface covered by many smaller domes. Inside, the complex, single cell contains thin strands called siphons surrounded by a uniform layer of bulb-shaped structures – a morphology that is typical of certain modern single-celled seaweeds from the genus Codium.

"It's very telling that such an organism has remained practically unchanged over at least 540 million years," says Aria. "By the Ediacaran, evolution had driven it towards a stable adaptive zone — it's been comfortable there since, and more than that, quite successful. So much so, in fact, that nowadays Codium takes advantage of global trade to easily outcompete other algal species."

Cosmos, 24 September 2022

https://cosmosmagazine.com

Algae cells pressed into service as pneumonia-treating microrobots

2022-09-26

Scientists have recently had success in curing mice of a serious type of pneumonia, using what are described as "microrobots." The bots were actually live algae cells, which carried life-saving medication throughout the rodents' lungs.

Led by professors Joseph Wang and Liangfang Zhang, a team at the University of California - San Diego set about treating a group of mice whose lungs were infected with pneumonia-causing Pseudomonas aeruginosa bacteria. If left unchecked, such infections can prove fatal.

For the treatment, individual Chlamydomonas reinhardtii microalgae cells were coated with biodegradable polymer nanospheres. Each of those spheres was filled with antibiotics, plus it was covered with the cell membranes of white blood cells called neutrophils. Those membranes are known for their ability to absorb and neutralize inflammatory molecules produced both by bacteria, and by the body's immune system.

The microrobots (aka microbots) were administered directly into the lungs of each mouse, via a tube inserted into its windpipe. Once delivered, the microalgae cells swam randomly through the lung passages, spreading their nanosphere payloads as they did so.

"Our goal is to do targeted drug delivery into more challenging parts of the body, like the lungs. And we want to do it in a way that is safe, easy, biocompatible and long-lasting."

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As a result, the bacterial infections cleared up within one week, and all of the treated mice survived past 30 days. By contrast, all members of an untreated control group died within three days of becoming infected.

Additionally, another group received the same antibiotics, but via intravenous injection. Although those mice did recover, they required a dosage that was 3,000 times higher than that used in the microrobot treatment. This was due to the fact that while the bots were delivered directly to where they were needed – the lungs – the IV-administered antibiotics were dispersed throughout the body.

What's more, after the bot-treated group recovered, their immune cells digested the algae cells and any remaining nanospheres, leaving nothing behind. The scientists now plan on conducting more research into how the microrobots interact with the host immune system, with hopes of moving on to larger animal and even human trials.

"Our goal is to do targeted drug delivery into more challenging parts of the body, like the lungs. And we want to do it in a way that is safe, easy, biocompatible and long-lasting," said Zhang. "That is what we've demonstrated in this work."

A paper on the study was recently published in the journal Nature Materials.

New Atlas, 26 September 2022

https://newatlas.com

99.7% in Only One Hour – New Nanocoating Kills More Bacteria Faster

2022-09-23

A new copper covering that kills bacteria faster and in greater amounts than existing formulations might be available for hospitals and other high-traffic locations in the near future.

Although current formulations comprised of pure copper are antibacterial and self-sanitizing, they kill certain forms of bacteria with a thicker cell wall (Gram-positive bacteria), more slowly than bacteria with a thinner cell wall (Gram-negative).

Using zinc and bacteria-killing nanoscale features, a team of the University of British Columbia researchers under the direction of Dr. Amanda Clifford, an assistant professor in the department of materials engineering, has

A new copper coating could be the next superbug fighter.

created a nano-copper coating. Small bumps known as nanoscale features have the power to kill bacteria by rupturing their cell walls. In contrast to pure copper alone, zinc, which is similarly antibacterial, selectively oxidizes in the presence of copper and aids in the faster killing of bacteria.

"Use of our coating could significantly reduce the incidence of contracting bacterial infections from high-touch surfaces in healthcare facilities, such as doorknobs and elevator buttons since it kills bacteria using multiple approaches," says Dr. Clifford. "As it contains less copper than other existing coatings or whole copper parts, it would also be cheaper to make."

The team found that the material took just one hour to kill 99.7 percent of Staphylococcus aureus—a Gram-positive pathogen commonly responsible for hospital-acquired infections— compared with two hours for pure copper.

"Not only does this coating kill pathogens faster than pure copper, it helps ensure antibiotics remain effective," said Dr. Clifford. "By using this new formulation, we're killing pathogens before patients become infected and need to use antibiotics against them, slowing the rise of antibiotic resistance."

The researchers have filed a provisional patent for the coating and fabrication process, which is described in a new paper in Advanced Materials Interfaces.

"This is currently targeted for hospitals and health care settings because these locations are where the antibiotic-resistant pathogens, such as methicillin-resistant Staphylococcus aureus (MRSA), are an issue. We also don't want to be at a place where we can't use antibiotics," says Dr. Clifford.

The team plans to further evaluate the material against other pathogens, such as viruses, with hopes of eventually commercializing their work.

Sci Tech Daily, 23 September 2022

https://scitechdaily.com

Patients in VR during surgery need less sedatives, trial finds

2022-09-26

A fascinating clinical trial has reported virtual reality immersion can reduce the amount of anesthetic needed during certain types of hand surgery.

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The trial found patients using VR could get through an entire surgical procedure with only local anesthetic.

Researchers are exploring a number of novel medical uses for VR technology, from using VR as a tool for managing chronic back pain to incorporating it into cutting-edge psychedelic therapies. But can VR be used to replace anesthesia in surgical procedures?

As a replacement for sedation during minor procedures such as endoscopy or complex wound dressing changes VR has proved somewhat effective. However, during more serious procedures, such as orthopedic surgery, the technology has not been as successful.

In this study the researchers focused on hand surgeries, increasingly common procedures that frequently require complete unconscious sedation with a drug called propofol. Brian P. O'Gara, senior author on the new study, said modifying the amount of sedation used in these procedures will make them safer for patients and quicker to complete.

"With the increase in the amount of time people spend at the keyboard combined with our aging population, there is a projected increased need for common elective hand surgeries," said O'Gara. "Optimizing care for these patients will undoubtedly involve modification to anesthetic practices."

The research recruited 34 patients scheduled for hand surgery and randomized them into either a VR or control group. The VR group wore a headset for the procedure and engaged in a calming experience of their choice, such as a 360-degree mountaintop environment.

The procedure started using only localized nerve-blocking anesthesia. At all stages of the surgery the patients could ask for either more local anesthetic or propofol to put them to sleep.

Only four out of the 17 patients in the VR group ultimately received propofol during the procedure, while every patient in the control group needed the more complete anesthesia. Interestingly, the VR patients ultimately used more local anesthetic in their procedures but were discharged from post-surgical care an average of 22 minutes earlier than patients in the control.

This suggests VR could offer a number of benefits to both patients and hospitals in certain contexts. Propofol sedation is not without minor risks, and in some frail patients it can lead to lingering complications.

Patients used VR and local nerve-blocking drugs but could request supplemental anesthetic or pain medication if required.

Lighter sedation also means shorter waiting periods for patients following surgical procedures, offering hospitals more efficient protocols for dealing with higher volumes of procedures.

"Our trial is novel in that it is the first to report a significant reduction in sedative dosing with VR immersion during hand surgery on adults," added O'Gara. "Using VR immersion, the potential harms of unnecessary sedation can be avoided without compromising patient comfort during hand surgery."

The new research was published in PLOS One.

New Atlas, 26 September 2022

https://newatlas.com

Scientists create 'non-psychedelic' compound with same anti-depressant effect

2022-09-28

While illegal for recreational use, psychedelic drugs are showing great promise as treatments for severe depression and anxiety, as well as alcohol addiction and other conditions. Some advocates and scientists believe the actual psychedelic trip—hallucinations and profound emotional experiences—is what leads to long-lasting therapeutic effects. Other scientists speculate that if the "trip" could be eliminated from such drugs, then only the therapeutic effects might remain. Researchers at UNC-Chapel Hill, UC San Francisco, Yale, Duke, and Stanford have taken a major step toward answering that question.

Published in Nature, this research in animal models show it's possible to create a compound that hits the same exact target as psychedelic drugs hit—the 5-HT2A serotonin receptors on the surface of specific neurons—but does not cause the same psychedelic effects when given to mice. The new compound triggers the same anti-depressant action that researchers have long observed in mice treated with SSRI drugs over the past two decades, with just two differences: the anti-depressant action of the new compound was immediate and long-lasting after just one dose.

"We were very surprised the compound had any anti-depressant activity similar to ketamine and psilocybin, both rapidly acting antidepressant psychedelic drugs," said co-senior author Bryan L. Roth, MD, Ph.D., the Michael Hooker Distinguished Professor of Pharmacology at the UNC School of Medicine and director of the NIMH Psychoactive Drug Screening

"It would be a game changer to create a one-dose, long-acting therapy to help people with treatment-resistant depression and other conditions."

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Program. "We were basically running a chemistry experiment to see if we could create a compound to activate 5-HT2A. Once we achieved that, we decided to run experiments in mice."

The compound is patented by Yale, UNC-Chapel Hill, and UCSF and licensed to Onsero, a company created to fine-tune experimental compounds before they can be further tested in clinical trials.

"We don't know if we'll see the same effects in people," Roth said. "But we hope to find out. It would be a game changer to create a one-dose, long-acting therapy to help people with treatment-resistant depression and other conditions."

The case for psychedelics

When someone eats a magic mushroom, the active ingredient pscilocin—which is derived from psilocybin—binds tightly to the 5-HT2A serotonin receptors on the surface of neurons. The receptor is activated for a long time, triggering a cascade of chemical signals inside cells. These cells then communicate to other cells throughout the brain, sending the person on a long, strange hallucinogenic trip for hours. For those who are treatment-resistant, psychedelic drugs can immediately alleviate depression, and the effect lasts for many months.

Ketamine, used medically as an anesthetic, also has become a tool against severe depression. In 2019, the FDA approved a prescription version of ketamine called esketamine (Spravato), administered through a nasal spray. Use of this drug requires supervision of a medical professional and is expensive. Ayahuasca—a brew that includes two psychoactive plants—also shows anti-depressant effects in uncontrolled clinical studies. It's illegal in the United States, as is one of its active ingredients—N, N-Dimethyltryptamine, also known as DMT.

Roth said it would be difficult to scale up these drugs to help the millions of people in need as these drugs and others can drastically change brain chemistry, to say the least, and, like LSD, carry risks. An individual's experience can be harrowing, despite coming out the other side feeling "cured" of depression, severe anxiety, or addiction.

A class of anti-depressant drugs called selective serotonin reuptake inhibitors (SSRIs) modulate serotonin signaling indirectly and not in the same way as psychedelic drugs do. SSRIs also enhance serotonin levels in cells throughout the body, which is likely one reason why these drugs can cause a wide swath of unpleasant side effects. Although SSRIs lead to the

immediate increase in serotonin in the brain, people who take these drugs do not typically report feeling the anti-depressant until weeks later.

"So, there's more going on than simply raising serotonin levels to treat depression," said Roth, who spent two decades seeing psychiatric patients. "SSRIs cause changes in the brain that lead to anti-depressive action. We don't know what's going on, exactly. But I know many people who have had their lives transformed by SSRIs and psychotherapy."

The idea, then, is simple: what if scientists could create a compound that selectively hits the 5-HT2A receptor but activates it in a way that alters brain chemistry to treat depression, leaving the trippy pathway alone while avoiding the side effects associated with SSRIs.

The full project took seven years, beginning when Roth's lab solved the complex chemical structure of serotonin receptors, including what they look like when a psychedelic compound is tightly bound to them. This, alone, took years.

In 2020, the Defense Advanced Research Projects Agency (DARPA) in the Department of Defense funded Roth and colleagues $26.9 million to create new medications that effectively and rapidly treat depression, anxiety, and substance abuse without major side effects. Roth secured this high-risk, high-reward project through his UNC lab's expertise, experience, and collaborations with experts in the field, including co-senior authors on the Nature paper Brian Shoichet, Ph.D., at the UC-San Francisco and others at Duke, Icahn School of Medicine at Mount Sinai, and Stanford.

Years of collaborative science

An expert in combinatorial chemistry, Jonathan Ellman, Ph.D., the Eugene Higgins Professor of Chemistry and professor of pharmacology at Yale co-first author Danielle Confair, Ph.D., now a senior scientist at AstraZeneca, led work to a develop a sequence of reactions that, with different starting materials, could theoretically lead to the creation of billions of new compounds with slightly different chemical structures. For this study, Ellman and Confair focused on chemical reactions for the synthesis of tetrahydropyridines, or THPs, which occur in nature and are the basic building blocks of many compounds, including medications.

Then Shoichet and UCSF co-first author Anat Levit, Ph.D. and co-senior author John Irwin, Ph.D., used computational simulations to home in on specific THP-based virtual compounds most likely to only bind to 5-HT2A in specific ways on certain neurons, not unlike how psilocybin binds

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to these receptors, but just differently enough to potentially avoid the dramatic psychedelic effect.

"For us, the project began as an opportunity to expand the new virtual libraries with 75 million tricked-out molecules from the Ellman lab," Shoichet said. "It was only when we started to see the unusual signaling from the new compounds and their amazing permeability into the brain that we as a team started to think these compounds might have interesting effects in vivo."

Then Roth's UNC lab, led by co-first author Kuglae Kim, Ph.D., selected and tested several actual compounds to see how they bind to the serotonin receptors in cell cultures. This part also took years. Receptors are complex and delicate bunches of perfectly situated proteins. To be able to observe a compound's effect on them is a laborious process involving various experimental techniques, including X-ray crystallography.

With each experiment, Roth and UNC colleagues learned more nuances about the compound's relationship to 5-HT2A. Shoichet's team then used that knowledge to tweak their computational chemical design to create yet another virtual compound that Roth's lab created in the real world.

This iterative process yielded a few compounds promising enough for Roth's lab to test in a mouse model, essentially to see if the compounds bound to 5-HT2A in an animal as it did in a lab dish.

"What we saw was completely unexpected," Roth said. "Not only did the compound bind the 5-HT2A serotonin receptor like we thought it would, but it had the same anti-depressant drug action as does ketamine but not the same hallucinogenic drug action."

While researchers can't know for sure if the mice were not depressed or hallucinating, they can study drug action—the biological effect in mice and then observe behaviors. For decades, researchers have used standard tests—forced swim test, tail suspension tests, novel suppressed feeding—when testing the action of compounds. Likewise, researchers have used standard mouse models of psychoactive drug action, models that have been validated over decades. Mice behave in specific ways, when given a hallucinogenic drug, sort of like humans behave in certain ways when tripping.

When the Duke lab of William Wetsel, Ph.D., gave mice the new compound, the research team observed the same anti-depressant drug action without the same psychoactive drug action.

"It was more than a little remarkable to us is that this compound was effective in all mouse models after a single dose, and the effect was long lasting, similar to psilocybin," Roth said. "We were lucky. And we know we're not finished."

Whether this drug or others like it can truly provide a one-dose, long-lasting anti-depressant effect for people with treatment-resistant depression, severe anxiety, and other conditions is yet to be determined. But this research shows that it might be possible.

Phys Org, 28 September 2022

https://phys.org

Half of world's bird species in decline as destruction of avian life intensifies

2022-09-28

Nearly half of the planet's bird species are in decline, according to a definitive report that paints the grimmest picture yet of the destruction of avian life.

The State of the World's Birds report, which is released every four years by BirdLife International, shows that the expansion and intensification of agriculture is putting pressure on 73% of species. Logging, invasive species, exploitation of natural resources and climate breakdown are the other main threats.

Globally, 49% of bird species are declining, one in eight are threatened with extinction and at least 187 species are confirmed or suspected to have gone extinct since 1500. Most of these have been endemic species living on islands, although there is an increase in birds now going extinct on larger land masses, particularly in tropical regions. In Ethiopia, for example, the conversion of grassland to farmland has caused an 80% decrease in endemic Liben larks since 2007. Just 6% of bird species globally are increasing.

Since 1970, 2.9 billion individual birds (29% of the total) have been destroyed in North America. The picture is just as bleak in other parts of the world – since 1980, 600 million birds (19%) have been destroyed in Europe, with previously abundant species such as the common swift, common snipe and rook among those slipping towards extinction. Europe's farmland birds have shown the most significant declines: 57% have disappeared as a result of increased mechanisation, use of chemicals

State of the World's Birds report warns human actions and climate crisis putting 49% in decline, with one in eight bird species under threat of extinction

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and converting land into crops. In Australia, 43% of abundant seabird species have declined between 2000 and 2016.

Dr Stuart Butchart, chief scientist at BirdLife International, said: "We have to stop these declines and start getting on track for recovery. Our future, as well as the world's birds, depends on it. If we continue to unravel the fabric of life, we're going to continue to place our own future at threat."

The report is made up of a compendium of other studies, and because birds are the best-studied group on the planet, it gives an idea of the state of nature more generally. "Birds are useful for telling us about the state of the planet. What they say is that nature is in poor condition, lots of species are in decline," said Butchart.

Birds are cornerstones of healthy ecosystems, so their disappearance is likely to have myriad negative knock-on effects. Hornbills, for example, disperse large seeds in tropical forests; turkey vultures dispose of organic waste, while seabirds help in the cycle of nutrients between sea and land, keeping coral reefs healthy.

The previous State of the World's Birds report, released in 2018, found 40% of bird species worldwide in decline.

Wildfires feature more prominently in this report than previous editions, having increased and ravaged previously unaffected habitats. The succession of heatwaves, droughts and floods in recent years will lead to widespread species extinctions if they continue, researchers warn, highlighting the importance of addressing the nature and climate crises at the same time.

Growing evidence links the health of bird populations to human health. Covid-19 is a warning of what could happen if we continue to destroy the natural world, with 70% of zoonotic diseases originating in wildlife. A highly pathogenic variant of avian flu – the result of intensive farming – has driven rapid declines in some bird populations this year. More than 300 outbreaks have been reported in UK seabird colonies.

The report comes ahead of the Cop15 meeting in Montreal in December, a once-in-a-decade opportunity to create new legislation to tackle the biodiversity crisis. Butchart hopes the findings will feed into the final statement from Montreal. "The key action needed now by governments is to make sure a really ambitious and bold global biodiversity framework is adopted. We've got to bend this curve, so by 2030 we're on a mission of being nature positive," he said.

This means increasing the number and quality of protected areas, conserving remaining habitats and restoring those that have been degraded. Preventing the illegal killing of birds, managing invasive species, reducing fisheries' bycatch and preventing overexploitation of natural resources will all help.

The report is not all gloom. According to BirdLife, between 21 and 32 bird species would have gone extinct since 1993 without conservation work. It cites the creation of a new seabird haven the size of France in the North Atlantic, estimated to protect 5 million birds.

Juliet Vickery, chief executive of the British Trust for Ornithology, who was not involved in compiling the report, said: "The fact that nearly half of all bird species are declining and one in eight is at risk of extinction reinforces the fact that we are living through a biodiversity crisis. It requires action at every level, from local to global. This carries a strong warning about the health of our natural world."

Birds in trouble

- The South American harpy eagle, which stands 1 metre (3 feet) tall and feeds on monkeys and sloths, is one of the world's largest birds of prey. It was uplisted from near threatened to vulnerable on the International Union for Conservation of Nature (IUCN) red list in 2021 because of a combination of forest loss, hunting, poaching and collisions with power lines. It has declined by 50% in 60 years.
- The secretary bird, a raptor from sub-Saharan Africa, went from being vulnerable to endangered in 2020 after habitat degradation driven by the burning of grasslands and intensive livestock grazing. Birds are also captured for the wildlife trade.
- The lesser florican, a species endemic to the Indian subcontinent whose males perform leaping rituals to get the attention of females, has declined by 90% in 20 years, mainly because of the loss of grassland habitats and the predation of its chicks by feral dogs. There are believed to be fewer than 1,000 mature individuals left, and it is now critically endangered.
- The impressive vocal abilities of the Central American yellow-naped Amazon has made it one of the most sought-after parrots in the pet trade. It has declined by more than 80% in 30 years, mainly due to poaching and the expansion of agriculture, and as of 2022 is critically endangered.

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- The Bahama warbler was badly affected by Hurricane Dorian in 2019, especially on Grand Bahama, where 95% of its habitat is believed to have been destroyed. It was listed as endangered in 2020.

The Guardian, 28 September 2022

https://theguardian.com

Women said coronavirus shots affect periods. New study shows they're right.

2022-09-27

Not long after the rollout of coronavirus vaccines last year, women around the country began posting on social media about what they believed was a strange side effect: changes to their periods.

Now, new research shows that many of the complaints were valid. A study of nearly 20,000 people around the world shows that getting vaccinated against covid can change the timing of the menstrual cycle. Vaccinated people experienced, on average, about a one-day delay in getting their periods, compared with those who hadn't been vaccinated.

The data for the study, published Tuesday in the British Medical Journal, was taken from a popular period-tracking app called Natural Cycles and included people from around the world, but most were from North America, Britain and Europe. The researchers used "de-identified" data from the app to compare menstrual cycles among 14,936 participants who were vaccinated and 4,686 who were not.

Because app users tracked their menstrual cycles each month, the researchers were able to analyze three menstrual cycles before vaccination and at least one cycle after, and compare them with four menstrual cycles in the unvaccinated group.

The data showed that vaccinated people got their periods 0.71 days late, on average, after the first dose of vaccine. However, people who received two vaccinations within one menstrual cycle experienced greater disruptions. In this group, the average increase in cycle length was four days, and 13 percent experienced a delay of eight days or more, compared with 5 percent in the control group.

Alison Edelman, a professor of obstetrics and gynecology at Oregon Health & Science University, who led the study, said that for most people the effects were temporary, lasting for one cycle before returning to

A coronavirus vaccination can change the timing of when you get your period, according to research. For most people, the effect was temporary.

normal. She said there were no indications that the period side effects had any impact on fertility.

"Now we can give people information about possibly what to expect with menstrual cycles," Edelman said. "So I hope that's overall really reassuring to individuals."

Researchers don't know exactly why the vaccines seem to affect menstrual cycles, but Edelman said that the immune and reproductive systems are linked and that inflammation or a strong immune response could trigger menstrual fluctuation.

Any change in getting your period can be stressful, triggering worries about an unplanned pregnancy or an illness, and people have expressed frustration that public health officials didn't warn them about the possible side effect or do more research before rolling out the vaccines.

One major limitation of the study is the fact that it included only those who were not on birth control, had regular cycles before getting vaccinated and were between the ages of 18 and 45.

The study also didn't answer all of the questions raised by people about vaccines and periods, including how the shots affect trans men and nonbinary individuals. Ever since the vaccines were rolled out, many people on social media have complained of longer, heavier and more-painful periods after getting vaccinated. This study did not look at the heaviness of periods or other side effects such as cramps, but researchers said it did show that, on average, getting vaccinated did not appear to cause longer periods.

Edelman said preliminary findings from a different study suggest that getting a coronavirus vaccine sometimes may cause heavier periods. The data, collected from nearly 10,000 people, is still undergoing peer review, but it showed that getting vaccinated increased slightly the probability of having heavier bleeding.

However, she acknowledged that her studies have looked only at people with normal menstrual cycles who aren't using hormonal contraceptives, and that individual experiences may vary widely.

Caiityya Pillai, 21, who lives in Berkeley, Calif., said that for two months after her March 2021 shot, her normally light period became extremely painful and lasted twice as long.

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"The pain wasn't like a normal pain. It was to the point where I was crying and could not get out of bed," she said.

Pillai said that she was overwhelmed with anxiety and thought something else might be wrong, but that after two cycles, her period returned to normal. When she got a second dose in July 2021, her period worsened again, but she said she felt calmer about it because she had seen similar stories being shared online.

Other research has suggested that the vaccines have a variety of effects on periods. A survey published last fall collected information about periods and vaccines from 160,000 people — including transgender and postmenopausal people — and found that thousands reported heavier bleeding than usual or breakthrough bleeding.

While these observations aren't necessarily medically alarming, Katharine Lee, an assistant professor at Tulane University who led the survey, said the information is important to help trans men plan for additional support if menstruating causes gender dysphoria, and also to help people make decisions about stocking up on tampons and pads.

Lorena Grundy, 27, uses an IUD and hadn't had her period for over three years before she got her first Pfizer shot in February 2021. The next day at work, she got her period.

"It wasn't that the vaccine moved my period early or late — it produced one," said Grundy, who lives in Somerville, Mass.

If she had been made aware of the side effect, she said, she would have prepared and brought a pad to work. Her period lasted three or four days — and it came back when she got her second vaccine dose three weeks later. But it didn't happen again when she got a booster shot last November.

"I think it's good to validate that we should listen to women about their own bodies," she said. "I'm still glad I got vaccinated, but I do think maybe this shows that it's a symptom we should be preparing people for so they're not alarmed by it."

Although Edelman's research suggested that period changes are temporary, some people have reported lasting shifts in menstrual cycles long after getting a shot.

Sammi Beechan, 32, of Hammond, Ore., said they used to have a "blessed, beautiful cycle" that came every 28 days "like clockwork" and resulted in mild cramps and only four days of light to medium bleeding.

After a Johnson & Johnson shot in April 2021, nothing changed, but after getting a Moderna booster that October, Beechan noticed that their period started to come every 24 days with more than four days of heavier bleeding, more-painful cramps and extreme mood shifts. Doctors have ruled out endometriosis and other potential health conditions as the cause.

Beechan said that getting vaccinated against covid is worth it but that they wish more information about period side effects had been provided ahead of the vaccine rollout. "I went from having very consistent expectations and now each month I'm like, okay, I guess this is what it is," Beechan said.

Diana Bianchi, the director of the Eunice Kennedy Shriver National Institute of Child Health and Human Development, which funded Edelman's research, said getting a significantly late period after vaccination is not necessarily cause for alarm.

"I wouldn't recommend going to a doctor after the first time that it happens, just because all the evidence indicates that the change resolves, it's only temporary," she said. "If it's a persistent change in the menstrual cycle interval, then that might be a reason to see your primary-care physician or OB/GYN."

The National Institutes of Health has funded at least four other research projects around coronavirus vaccines and menstruation — some of which look at adolescents and people with endometriosis — with the hope of providing better information and increasing public trust in the vaccines.

Olivia Rodriguez, 26, said she doesn't plan to get her booster shot because she had such a bad experience after her second Moderna shot in March 2021. Despite just having finished her period, she started another within a few days of getting the shot. It lasted 10 days with heavier bleeding, she said, instead of the normal four or five days she was used to. She also experienced more-painful cramps.

Initially, she panicked, but soon found stories online of other women who had gone through similar situations. It was reassuring, she said, but she still is wary of getting another shot.

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Rodriguez, who is a member of the Osage Nation, said medical researchers need to earn the trust of the Indigenous and people of color by providing more information upfront about side effects.

"I never really got an explanation of why or what happened," she said.

Washington Post, 27 September 2022

https://washingtonpost.com

Next-generation liquid biopsy detects nano-sized signs of breast cancer in early-stage patients

2022-09-29

A USC-led team of scientists has found indications that a special blood test called a liquid biopsy could determine whether a patient has breast cancer at its early stage and if that cancer is unlikely to return.

These high-definition comprehensive liquid biopsies are conducted using a standard blood draw from the arm of a patient in a doctor's office. Once in the laboratory, the sample is examined for signs of cancer.

The study demonstrating the liquid biopsy results for early breast cancer detection was published on Sept. 27 in Nature's npj Breast Cancer journal. The work was a collaboration between USC, Billings Clinic, Duke University, Epic Sciences and USC Norris Comprehensive Cancer Center. The results raise hopes that one day doctors could detect breast cancer in patients with a simple blood draw.

The researchers at the USC Michelson Convergent Science Institute in Cancer (CSI-Cancer) are cautiously optimistic about their findings. They are eager to test and see whether the results will be proven in larger clinical trials to demonstrate the benefit of the method for patients everywhere.

"It's an amazing opportunity to change how early breast cancer detection is being done with a simple blood draw, but it's only a research outcome at this point and we still need to demonstrate clinical benefit," said Peter Kuhn, a USC cancer physicist who directs CSI-Cancer.

Breast cancer is the most prevalent form of cancer in the world, affecting 1 in 8 women over their lifetime.

Since 1976 when the American Cancer Society endorsed the technique, mammography X-ray, along with a tissue biopsy, has become the standard way for doctors to check patients for breast cancer.

These high-definition comprehensive liquid biopsies are conducted using a standard blood draw from the arm of a patient in a doctor's office.

But mammography is not 100% accurate and its detection can be impeded by healthy dense tissue. Mammography's sensitivity to breast cancer is around 87%, according to the Breast Cancer Surveillance Consortium. And for some women, mammograms are not accessible, especially those living in poor isolated communities that have no clinics or hospitals. Others simply do not get a regular mammogram.

But a tissue biopsy also is not a fool-proof method. Although it can reveal information about the tumor, it has limitations. Doctors can sample only a small area and may fail to capture the full extent of the tumor. A tissue biopsy is also invasive and painful.

Combined, the drawbacks for diagnosis with mammograms and tissue biopsies mean some patients are not diagnosed until the cancer has grown and spread. New methodologies such as CSI-Cancer's liquid biopsy can bring a complementary toolset into clinical practice.

For the study, Kuhn and his team worked with 100 breast cancer patients—some early and late stage—and 40 patients without breast cancer from April 2013 through January 2017. The work was conducted at clinical sites including at the Norris Comprehensive Cancer Center at Keck Medicine of USC, the Billings Clinic in Montana, Duke University Cancer Institute in Durham, North Carolina and the City of Hope Comprehensive Cancer Center in Duarte, Calif.

The team tested a theory that the high-definition liquid biopsy could detect multiple cancer biomarkers, including the so-called "oncosomes"—nano-sized, membraned cargo carriers that enrich the body's environment for cancer growth. These oncosomes are secreted by cancer cells as the group has shown previously.

"The news here is that we found the vast majority of early-stage breast cancer patients have these oncosomes at very robust levels," said Kuhn, a Dean's Professor at USC Dornsife College of Letters, Arts and Sciences and cancer physicist. "They're about 5-10 microns in diameter. About the size of a cell. We first identified these large vesicles in prostate cancer about a year-and-a-half ago and showed that they are related to the cancer. They are hiding in plain sight."

If further studies produce similar results, this could mean that the next generation high-definition liquid biopsy may become a diagnostic tool for early breast cancer detection and other cancers, he said. The test also could inform patients who have been treated for cancer that they will most likely remain cancer-free.

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"Typically, I'm the bearer of bad news. I say, 'You have cancer in your blood," Kuhn said. "But a test like this could give hope that if there is a sign of cancer, we can find it very early and improve treatment and survival."

Medical Xpress, 29 September 2022

https://medicalxpress.com

Lithium resource squeeze could put the brakes on decarbonization

2022-09-22

As the EV revolution speeds up, and big battery projects ramp up to stabilize power grids running on intermittent renewables, global demand for lithium batteries will rise sixfold in the next 10 years. But can the world actually supply the materials?

There are many potential emerging alternatives to lithium batteries, but for the time being, lithium remains the best commercially available option for a wide range of use cases, and it's unclear what will rise to replace it, or when. We're already getting a small taste of a lithium squeeze, thanks to a freak heat wave that disrupted supply in China's Sichuan province last month.

A new report from EV supply chain market intelligence publisher Benchmark gives us a sense of what rising battery adoption means at the resources level. Even assuming the recycling of raw materials, the report suggests we'll need about 336 new average-sized mines by 2035.

That breaks down into around 59 new lithium mines producing an average of 45,000 tonnes, 38 new cobalt mines producing 5,000 tonnes, 72 new nickel mines producing around 42,500 tonnes, 97 new natural flake graphite mines producing around 56,000 tonnes a year, and 54 new synthetic graphite plants producing an average of 57,000 tonnes each per year.

Looking at lithium specifically, this soft, silvery-white metal is projected to be in surplus in the short term, according to the International Energy Agency, but by 2030, existing mines and projects under construction will only be able to produce about half of what's needed to satisfy demand. What's more, the same report found that lithium mines that started operations between 2010-2019 took an average of 16.5 years to develop.

Add to that the fact that these mines will need to be up and running by 2033 in order to feed the supply chain for 2035, and it starts to become clear that a number of new operations will need to ramp up at unprecedented speed to avoid a crushing lithium squeeze.

The demand won't stop rising there, either. The World Economic Forum estimates that around two billion electric vehicles will be needed by 2050 for a global net zero carbon push – up from around 16.5 million on the world's roads today. Large jurisdictions like the European Union, China,

The lithium battery has been one of the key foundational pillars underpinning the world's technological progress in the last couple of decades.

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Japan and a number of US states are bringing in legislation to speed up the transition, putting end dates on the sale of fossil-fueled cars. Are they planning to walk these dates back if there simply aren't enough batteries to make EVs?

The supply picture looks worse still if solid-state lithium batteries take off quicker than expected; their pure lithium anodes could push demand higher by up to 22% over current projections. And huge grid battery projects will rise in proportion to the share of renewables in each country's energy mix – although since physical size and weight are less important, other technologies like flow batteries could step into this space.

Another issue is water. Conventional lithium extraction requires huge quantities of water, and most of the world's biggest reserves are found in areas where water scarcity and drought is already an issue, like Australia, Chile, Argentina and Bolivia. And some operations potentially contaminate local groundwater with metals such as antimony and arsenic, making them very unpopular with farmers and residents.

There are some promising-looking extraction alternatives, like this Saudi research into cheap lithium production from seawater – which desalinates the seawater in the process, and also generates hydrogen and chlorine gases as additional revenue streams. This is a lab prototype, not a large-scale commercial operation, and while there's plenty of lithium in the sea, there's certainly no guarantee that this nascent process, or other similar ones, will prove scalable enough to fill the coming hole in supply.

The lithium battery has been one of the key foundational pillars underpinning the world's technological progress in the last couple of decades. Without them, the cell phone couldn't have become the smartphone. Absent the groundbreaking power and energy density of lithium, drones and eVTOLs make no sense, many portable and mobile devices would never have made it to market, and electric vehicles would be hamstrung by crippling range figures, so hydrogen-based powertrains might be the only practical path toward decarbonization.

But it seems very likely that an extended lithium squeeze will hit within the next few years, pushing up battery prices and putting some harsh brakes on global decarbonization trajectories in the coming decades. So

the development and commercial rollout of alternative battery and clean fuel technologies is of critical importance.

New Atlas, 22 September 2022

https://newatlas.com

'Holy $@*%!' Science captures behind-the-scenes reactions to asteroid-smashing mission

2022-09-27

Second by second, as a NASA satellite hurtled toward a pile of rocks in space, scientists gathered at the Johns Hopkins University Applied Physics Laboratory issued their unfiltered analysis.

"It doesn't look like any asteroid I've ever seen!"

"That's totally a rubble pile—I knew it!"

"Holy shit!"

In the final moments of the Double Asteroid Redirection Test (DART), researchers who had spent years designing and simulating the spacecraft's collision with the moon of a larger asteroid were glued to the TV. They greeted each new image with heartier applause. Then, the screen flashed bright red as the satellite lost signal on impact.

Satellite's successful slam into space rock demonstrates ability to deflect cosmic danger.

The scientists' tear-stained cheeks lit up with reflected light, and the crowd erupted. A bouquet of fireworks sprouted from behind the building. Humanity's first-ever planetary defense test—which could one day help scientists deflect an asteroid on a collision course with our planet—was, quite literally, a smashing success.

Some in the room were simply dumbfounded. "I'm stumped," says Jessica Sunshine, a planetary scientist at the University of Maryland (UMD), College Park, and DART investigator. "We knew it was going to be exciting, and I thought it was going to work, but nobody could have predicted that."

Though measurements from the impact will keep scientists busy for months to come, one early surprise came from DART's images of the double-asteroid system just before the crash. From previous radar observations, astronomers had a hazy idea that the larger body would be shaped like a spinning top. "But [its] shape was way different … it was so flattened compared to what we expected," says Harrison Agrusa, an astronomer at UMD and DART member.

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Meanwhile, the smaller asteroid—DART's ultimate target—appeared shockingly spherical. The moon's symmetrical rubble-pile structure hints that it may have formed from material shed off the parent body as it spun, Agrusa adds. Knowing the shape and composition of these celestial objects will help astronomers better understand their origins and orbits.

The DART satellite, roughly the size and mass of a cow, was launched in November 2021 toward a 780-meter asteroid named Didymos. Ten months later, about an hour before impact, the spacecraft spied its final resting place: Dimorphos, the 160-meter-wide moon. The DART team members had prepared a series of last-second emergency maneuvers in case the satellite's autonomous navigation malfunctioned, but in the end, they didn't have to touch a thing. As planned, DART crashed into its target at 6 kilometers per second.

"We are so excited to be done," says Elena Adams, a DART mission systems engineer. "I can finally sleep."

But not everyone was off to bed so quickly. Halfway across the globe and late into their night, two astronomers huddled in a lounge of the South African Astronomical Observatory. When DART's transmission cut to red, Amanda Sickafoose and Nicolas Erasmus turned their heads to footage of the impact they'd captured with the Lesedi telescope. They hoped to see confirmation in the form of a gradual brightening of the asteroid system, as dust and rocks knocked off the asteroid would reflect more sunlight toward the telescope. What they got was even clearer: Within seconds of the impact, they watched in exquisite detail as the asteroid sneezed out a plume of ejecta. "We were astonished," Sickafoose says.

Dozens of astronomers—professional and amateur—from all seven continents watched the collision in real-time. Through the night, scenes captured by observatories circled through DART's internal channels.

"The entire team was going bonkers," says Alan Fitzsimmons, an astronomer at Queen's University Belfast and DART observer. "The data is just incredible. … You couldn't have asked for a better test of a kinetic impactor."

Over the next few days, LICIACube, a small satellite that DART ejected 2 weeks before the crash, will release more images of the asteroids. Meanwhile, the James Webb and Hubble space telescopes will get better pictures of the cloud of ejecta streaming from the surface. By studying the change in light from the system, scientists will seek to decode the change

in the moon's orbit, which will indicate how effective DART's strike was in altering its trajectory.

For now, NASA scientists are hailing the test mission as a success. Still, a major challenge remains in humanity's ability to thwart threatening space rocks: "We can't use these techniques unless we know where the objects are," says Amy Mainzer, an astronomer at the University of Arizona. "If you can't find them, you certainly can't deflect them."

Of the Dimorphos-size asteroids that could destroy a large city or small country, astronomers estimate they've only found about 40%. NASA has plans to identify and track 90% of these looming threats with NEO Surveyor, a space-based telescope led by Mainzer. But because of a lack of funding, the mission remains delayed until at least 2026.

Some hope DART's success will help fuel the effort to identify lingering planetary threats. Yesterday, we couldn't be sure we could divert an asteroid barreling toward Earth. "Today, we can," Fitzsimmons says. "DART has basically shown us that we are not like the dinosaurs. So, let's find those asteroids … and let's do something about it."

Science, 27 September 2022

https://science.org

How birds of prey are exposing a toxic time bomb

2022-09-25

Rui Lourenço first started collecting eagle-owl feathers because they were beautiful. Below the birds' cliff-side nests in rural Portugal, he would find their shed feathers and bring them back to his ecology lab at the University of Évora. "It was just the typical curiosity of a naturalist," he says. "Especially the flight feathers, they're large, they're soft, they have really interesting patterns."

One day, a colleague asked if she could check them for toxic chemicals. As top predators, raptors' concentration of chemicals is particularly high due to a phenomenon called biomagnification in which concentrations increase as you go up the food chain. This means that monitoring them can help reveal what substances are polluting the natural world. Lourenço now regularly sends feathers for analysis. "They work as an alert system not only for predators, but for the environment and humans," he says.

And we need to be alerted. This year, a team of scientists warned that we had probably breached the planetary boundary for how much chemical

Researchers are finding chemicals that have not been fully tested for their environmental impact in eagles, owls and falcons – a sign of widespread, persistent pollution.

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pollution the Earth can handle and still remain a suitable home for human beings. Since the release of new chemicals now far outstrips our ability to test and regulate them, they argue, the situation is out of control.

Then, last month a paper showed that just one class of chemicals – per- and polyfluoroalkyl substances (PFASs), also known as "forever chemicals" because they do not break down in the environment – is now ubiquitous in Earth's rainwater at concentrations above the safe drinking limit. "At the UN environment programme, they talk now consistently about the triple crisis: climate, biodiversity and pollution," says Linn Persson from the Swedish Society for Nature Conservation, who co-authored the planetary boundary warning.

Chemical pollution is a vast problem, the depth of which is still unclear because many chemicals are not extensively tested for their environmental impact and not routinely monitored. This means that analysing raptors and other top predators is one of the only ways to tell how bad the situation really is – and how to save it.

'There are around 350,000 substances marketed worldwide and around 100,000 of these are marketed in the EU," says ecotoxicologist Paola Movalli. "Of these, only about 500 are well-characterised for their [hazards and] exposure." That leaves a huge knowledge gap for scientists and for regulators deciding where to step in. "You can't regulate something unless you know whether it's a problem and why it's a problem," says Daniel Lapworth, who researches groundwater pollution at the British Geological Survey.

Since 2007, the EU has had Reach, a regulatory framework for industrial chemicals not covered by food, medicine or agricultural legislation, and post-Brexit, the UK has UK Reach. While similar, UK Reach is starting to diverge on what substances to regulate and how. "[We] are trying to create a UK version of it rather than just what we acquired on the day we left the EU," says Andrew Smith, a regulatory scientist at the UK's Health and Safety Executive. Under either system, however, companies must provide substance dossiers with information on hazards to human health and potential environmental effects.

But the lower the amount produced or imported, the fewer tests are required. The European Environment Agency estimates that more than 70,000 mostly low-volume chemicals have little to no toxicity information available. On top of that, reports from the German Environment Agency show that at least a quarter of dossier datasets for medium and high-volume chemicals do not actually comply with Reach's requirements. "We

are producing tens of thousands of different compounds," says Lapworth, "but for many of them, we don't have the toxicity data."

Most under-studied chemicals face no regulation and are not routinely monitored. Scientists, however, have started to find some of them in the environment: in water supplies, the Arctic and now in top predators such as birds of prey. Dubbed "emerging contaminants" (ECs), their presence is worrying because it suggests that they build up in living organisms and do not easily break down. Such pollution is very difficult to reverse and can cause problems for decades: for example, polychlorinated biphenyls were banned in the 1980s, but still seem to cause infertility in Britain's last orcas.

ECs are not necessarily new in the environment, but advanced mass spectrometry techniques mean that scientists can now spot more and more of them. They give an almost complete picture of "the 'universe' of chemicals in the environment", says Movalli, who is based at the Naturalis Biodiversity Centre in the Netherlands. That is critical because wildlife is exposed to chemicals in combination, not one by one.

For example, a study this year found an overwhelming 85 contaminants in 30 white-tailed eagles from northern Germany, including pharmaceuticals, musk fragrances, pesticides and PFASs. While some were long-banned chemicals such as DDT, still frequently found in wild animals after over 40 years of restrictions, many were ECs. Other recent raptor studies also report detecting new types of flame retardants, UV filters from sunscreens and plastic additives such as bisphenols.

PFASs are a particular concern, says ecotoxicologist Veerle Jaspers from the Norwegian University of Science and Technology. They are used for all kinds of things, such as lining takeaway bags and waterproofing raincoats, and some have been linked to hormone and immune disruptions as well as cancer in humans. Jaspers has found PFASs in eagle-owls in Norway and has seen "very clear effects" of them in the lab.

In one study, she and her team tested the effect of a now restricted PFAS against an unregulated alternative in chicken eggs, at comparable concentrations to those observed for PFASs in wild eggs. They found that both chemicals altered the chicks' heart rate, potentially imperilling their hatching. At a higher dose, which was still significantly less than the reported PFAS exposure in eggs close to European chemical plants, the unrestricted alternative also resulted in abnormally large livers.

And because there are so many of them, they also make up a complex cocktail on their own. Movalli and her colleagues recently detected 56

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different PFAS compounds across nine species, including buzzards. Only two are currently banned by Reach and the Stockholm Convention, an international treaty that tackles persistent pollutants worldwide.

Research like Jaspers's and Movalli's suggest that exposure is significant and widespread in the environment, so it is no surprise that people are also exposed to many ECs. After all, we are surrounded by them: we put them straight on our skin and cook our food with utensils covered with them. According to estimates, almost everyone on Earth has PFASs in their blood.

That exposure is full of unknowns, even for chemicals we are beginning to understand better. Take the plastic additive and endocrine disruptor bisphenol A (BPA). In 2015, the European Food Safety Authority (EFSA) concluded that normal exposure was way under the safety limit and posed no health risk to the public. But in late 2021, it suggested lowering that limit by many orders of magnitude due to new evidence. This would mean that it now considers most people to be ingesting too much.

As with raptors, biomonitoring can bring clarity here. Environmental epidemiologist Carl-Gustaf Bornehag from Karlstad University runs a large human biomonitoring project called Selma on endocrine disruptors. In a paper published in Science earlier this year, he and his colleagues showed how considering the broader endocrine-disrupting mix of chemicals we are exposed to can help us judge our risk from them better.

"We have a risk assessment system [of chemicals today] where we take one compound at a time," he says, "but we are always exposed to very complicated mixtures." In the study, he identified a mix of chemicals from the blood and urine of nearly 2,000 pregnant Swedes that was associated with having children with a language delay. It consisted of BPA, phthalates and various PFASs.

His colleagues then extensively tested the mix in tadpoles, zebrafish and lab-grown human "mini-brains". They found significant hormone disruption that increased with dosage. Based on these experiments, the team defined a level of concern before checking the pregnant Swedes: a whopping 54% were above the threshold. Considering the effect of mixtures revealed by biomonitoring, Bornehag says, the safety limit of many everyday chemicals might need to be lowered.

According to Jaspers, however, sufficient action on problematic chemicals can take decades, whether it is to protect humans or wildlife. Movalli shares her frustration: "When a chemical is restricted or banned after

years of studies, industry simply replaces it with a similar one," she says. "It then takes more years of studies to restrict the new substance – repeat ad infinitum."

Bornehag says he saw the exchange of one phthalate for the next throughout the 2000s. In certain cases, BPA has also been swapped for other endocrine-disrupting bisphenols in products where BPA has been restricted and some replacement flame retardants show similar toxicity to their banned predecessors. But to Smith, it is not as black and white as that. Just take asbestos, he says. Industry is "always going to be very wary of anything that looks like asbestos. The last thing they want to do is to be accused of creating the next big problem."

One way to circumvent this is to group and regulate substances together. That does look set to become more common: member states are preparing a proposal for the EU to ban most PFASs and the European Commission recently published its vision for restricting a huge number of harmful chemicals by group as part of its new chemicals strategy. At the same time, the EFSA is looking to consider chemical mixtures in its risk assessments.

"[Grouping chemicals] is increasingly what we want to do because it is much more efficient," says Smith, though with regard to PFASs, he says they are more varied than most people realise. The UK recommendation on how to deal with PFASs, including potential restrictions, was expected this summer but has yet to be published. Similarly, the UK's delayed chemicals strategy, which was proposed in 2018 with the 25-year environment plan, is expected some time this year.

With the EU's new strategy signalling a step change, there are fears that UK Reach will fall behind. "Any divergence or any kind of delays in making decisions about particular groups of contaminants [could cause] a problem," says Lapworth. "It's potentially a dilution of the gold standard that we were working in line with."

Persson and her co-authors worry that trying to assess all the chemicals out there is too big a job, a view they share with the European Environment Agency. "The constant inflow of new substances that we synthesise is so much quicker than our capacity to assess," she says, especially on a global scale. Instead, she and co-authors floated the idea of a fixed cap on chemical production, inspired by emissions caps in the fight against global heating

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This idea might find sympathy among the ecotoxicologists who study raptors. When you ask Movalli what chemical worries her most in relation to the peregrine falcons she monitors, you get a list that goes on for some time. PFASs, old toxic metals, the long-banned dioxins, endocrine disruptors, even stimulants such as nicotine. "Sincerely, I am worried about everything," she says.

The Guardian, 25 September 2022

https://theguardian.com

The physics of walking is simpler than we thought

2022-09-26

The physics of walking for multi-legged animals and robots is simpler than previously thought. That is the finding described by a team of roboticists, physicists and biologists in the Proceedings of the National Academy of Sciences, in a paper titled "Walking is like slithering: a unifying, data-driven view of locomotion."

"This is important because it will allow roboticists to build much simpler models to describe the way robots walk and move through the world," said paper coauthor Nick Gravish, a faculty member in the Department of Mechanical and Aerospace Engineering at the University of California San Diego.

The researchers had previously studied ant walking and wanted to see how their findings could be applied to robots. In the process, they discovered a new mathematical relationship between walking, skipping, slithering and swimming in viscous fluids for multi-legged animals and bots.

The team studied several colonies of Argentine ants at UC San Diego, and two different types of multi-legged robots at the University of Michigan.

"Argentine ants are very easy to study in the lab," said paper coauthor Glenna Clifton, a faculty member at the University of Portland, who conducted most of the ant research while she was a postdoctoral scholar in Gravish's lab at UC San Diego.

Argentine ants are good walkers that can go long distances over various terrains. These ants also easily acclimate to lab settings, rebuilding their colonies quickly. Researchers then can motivate them to walk by placing food in specific locations. "These ants will set up foraging trails and follow

The mathematics the researchers used aren't new. But the math was understood to only apply to slithering and swimming in viscous liquids.

them," Clifton said. "They bounce back quickly and they don't hold a grudge."

To study these different animals and robots, researchers used an algorithm developed by the research group of Shai Revzen at the University of Michigan, which turns complex body motions into shapes. "This algorithm allows us to create a simple relationship between what posture you're in and where you are going to move next," Gravish said.

The researchers found that the same algorithms could be applied both to ants and the two different types of robots in the study, even though the amount of slipping motions when they walk differs widely.

Argentine ants also don't slip much when they walk – just 4.7% of total motion. By contrast, that slipping percentage is 12% to 22% for the six-legged BigANT robot and 40% to 100% for the multipod robots with six to 12 legs in the study, which sometimes crawl.

By using this model, researchers can predict where the insect or robot is going to move next simply based on what posture–or shape–they're making. "This provides a universal model for location that applies whenever the movement is dominated by friction with the environment," the researchers write.

The mathematics the researchers used aren't new. But the math was understood to only apply to slithering and swimming in viscous liquids. The team showed that the same equations apply to multi-legged walking, whether the walkers are slipping or not. In addition, the same rules apply from millimeter-scale insects, such as ants, to meter-scale robots. An early version of the paper title was "walking like a worm."

"The universality of this approach may have applications in robot design and motion planning, and provides insight into the evolution and control of legged locomotion," the researchers write.

Researchers hypothesize that these universal principles may have implications for understanding major evolutionary transitions, for example from swimming to walking. Given that walking, even with slipping, follows the same general control principles as viscous swimming, early land animals might already have had the neural circuitry needed for locomotion on land.

Researchers didn't study two-legged creatures, but the model would apply to them as long as they move slowly; have both feet on the ground at the same time; and do not fall.

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The team still has more fine tuning to do, to understand, for example, the role friction forces play in the model.

"Either way, walking can be much simpler than we usually think," Gravish said.

The Brighter Side of News, 26 September 2022

https://thebrighterside.news

Could Alzheimer's be an autoimmune disease?

2022-09-28

Searching for an Alzheimer's cure is among the world's most pressing needs. Researchers in Canada have a new theory.

Alzheimer's is a degenerative brain disease with no cure and no effective therapeutic treatments to stop or slow its progression. It impacts an estimated 50 million people around the world, and for those afflicted, invariably results in dementia and death.

In Australia Alzheimer's affects up to 1 in 10 Australians over 65 years of age, and up to 3 in 10 over 85. It is not a normal part of ageing.

One prevailing theory suggests that a sticky protein called beta-amyloid builds up in the brain forming clumps known as plaques, which then acts to kill brain cells, directly causing Alzheimer's disease. However, 30 years of research into the development of medical treatments designed to target these plaques have led to failure after failure.

Now, scientists at the Krembil Brain Institute, which is part of the University Health Network in Ontario, Canada suggest that new thinking around the disease is desperately needed.

They are asking: "Could Alzheimer's be an autoimmune disease?"

"Yes," says Dr. Donald Weaver, co-Director of the Krembil Brain Institute and author of new research published in the peer-reviewed journal, Alzheimer's & Dementia. "We don't think of Alzheimer's as fundamentally a disease of the brain. We think of it as a disease of the immune system within the brain."

The role of beta-amyloid in the brain is as an 'immunopeptide' – a messenger within the immune system which is involved in repairing the brain. "If we have head trauma, beta-amyloid repairs it. If a virus or a bacteria comes along, beta-amyloid is there to fight it," explains Weaver.

Alzheimer's might be a result of the body's immune system mistakenly attacking its own brain.

But unfortunately, beta-amyloid can become confused.

"Beta-amyloid gets confused and can't tell the difference between a bacteria and a brain cell," says Weaver. "And so, it inadvertently attacks our own brain cells. This, then, becomes what we call an autoimmune disease."

To test these ideas, the team surveyed the disease and patient literature to develop a detailed model describing the cause and effect relationship of Alzheimer's disease (known as a mechanistic model).

This approach allowed them to step back and take a more holistic review of the workings of the disease at several different levels within the biological system — such as Alzheimer's progression and effect on different sections of the brain's nerve cells, and the larger immune disease response — and also to consider novel causes and inputs into the disease.

Tangible rethinking about Alzheimer's disease as an autoimmune disease, and beta-amyloid as a normal part of our immune system, opens the door to new avenues and approaches to develop innovative new therapies, says Dr. Weaver, who hopes that this new conceptual framework could eventually present a new way to combat this insidious and devastating disease.

Cosmos, 28 September 2022

https://cosmosmagazine.com

Climate change is turning trees into gluttons

2022-09-27

Trees have long been known to buffer humans from the worst effects of climate change by pulling carbon dioxide from the atmosphere. Now new research shows just how much forests have been bulking up on that excess carbon.

The study, recently published in the Journal Nature Communications, finds that elevated carbon dioxide levels in the atmosphere have increased wood volume—or the biomass—of forests in the United States.

Although other factors like climate and pests can somewhat affect a tree's volume, the study found that elevated carbon levels consistently led to an increase of wood volume in 10 different temperate forest groups across the country. This suggests that trees are helping to shield Earth's ecosystem from the impacts of global warming through their rapid growth.

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Trees have long been known to buffer humans from the worst effects of climate change by pulling carbon dioxide from the atmosphere.

"Forests are taking carbon out of the atmosphere at a rate of about 13% of our gross emissions," said Brent Sohngen, co-author of the study and professor of environmental and resource economics at The Ohio State University. "While we're putting billions of tons of carbon dioxide into the atmosphere, we're actually taking much of it out just by letting our forests grow."

This phenomenon is called carbon fertilization: An influx of carbon dioxide increases a plant's rate of photosynthesis, which combines energy from the sun, water, and nutrients from the ground and air to produce fuel for life and spurs plant growth.

"It's well known that when you put a ton of carbon dioxide in the atmosphere, it doesn't stay up there forever," Sohngen said. "A massive amount of it falls into the oceans, while the rest of it is taken up by trees and wetlands and those kinds of areas."

Over the last two decades, forests in the United States have sequestered about 700-800 million tons of carbon dioxide per year, which, according to the study, accounts for roughly 10% to 11% of the country's total carbon dioxide emissions. While exposure to high levels of carbon dioxide can have ill effects on natural systems and infrastructure, trees have no issue gluttoning themselves on Earth's extra supply of the greenhouse gas.

To put it in perspective, if you imagine a tree as just a huge cylinder, the added volume the study finds essentially amounts to an extra tree ring, Sohngen said. Although such growth may not be noticeable to the average person, compared to the trees of 30 years ago, modern vegetation is about 20% to 30% bigger than it used to be. If applied to the Coast Redwood forests—home to some of the largest trees in the world—even a modest percentage increase means a lot of additional carbon storage in forests. Researchers also found that even older large trees continue adding biomass as they age due to elevated carbon dioxide levels.

Unlike the effects of climate change, which varies over location and in time, the amount of carbon dioxide in the atmosphere mixes almost evenly, so every place on Earth has nearly the same amount, Sohngen said.

So to test whether the chemical compound was responsible for beefing up our biome, Sohngen's team used historical data from the U.S. Forest Service Forest Inventory and Analysis Program (USFS-FIA) to compare how the wood volume of certain forest groups has changed over the past few decades. The study estimates that between 1970 and 2015, there was a

significant increase in trees' wood volume, which correlates with a distinct rise in carbon emissions.

Researchers were also able to use this method to test whether there were differences in naturally occurring trees versus trees that were planted. Sohngen thought that planted trees would undergo a bigger fertilization effect, as they have an advantage in that planters often pick the best seeds to plant in only the best locations. On the contrary, he was surprised to find that planted trees respond to carbon dioxide levels in the same way natural ones do.

Overall, Sohngen said this work shows that the wood volume response to carbon dioxide in our ecosystem is even higher than his colleagues predicted with experimental studies.

The results should show policymakers and others the value of trees in mitigating climate change. Sohngen said that carbon fertilization could one day make tree-growing efforts more efficient. For instance, if it costs $50 to plant one acre of trees today, with the help of carbon fertilization, that number could easily be decreased to $40. As climate change costs the United States about $2 trillion each year, that decrease could help drive down the cost of mitigating climate change, Sohngen said.

"Carbon fertilization certainly makes it cheaper to plant trees, avoid deforestation, or do other activities related to trying to enhance the carbon sink in forests," Sohngen said. "We should be planting more trees and preserving older ones, because at the end of the day they're probably our best bet for mitigating climate change."

Phys Org, 27 September 2022

https://phys.org

Why do most life-long smokers never develop lung cancer?

2022-09-29

Cigarette smoking is overwhelmingly the main cause of lung cancer, yet only a minority of smokers develop the disease. A study led by scientists at Albert Einstein College of Medicine and published online in Nature Genetics suggests that some smokers may have robust mechanisms that protect them from lung cancer by limiting mutations.

The findings could help identify those smokers who face an increased risk for the disease and therefore warrant especially close monitoring.

Study suggests that some smokers may have robust mechanisms that protect them from lung cancer.

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"This may prove to be an important step toward the prevention and early detection of lung cancer risk and away from the current herculean efforts needed to battle late-stage disease, where the majority of health expenditures and misery occur," said Simon Spivack, M.D., M.P.H., a co-senior author of the study, professor of medicine, of epidemiology & population health, and of genetics at Einstein, and a pulmonologist at Montefiore Health System.

Overcoming Obstacles to Study Cell Mutations

It's long been assumed that smoking leads to lung cancer by triggering DNA mutations in normal lung cells. "But that could never be proven until our study, since there was no way to accurately quantify mutations in normal cells," said Jan Vijg, Ph.D., a study co-senior author and professor and chair of genetics, professor of ophthalmology and visual sciences, and the Lola and Saul Kramer Chair in Molecular Genetics at Einstein (also at the Center for Single-Cell Omics, Jiaotong University School of Medicine in Shanghai, China).

Dr. Vijg overcame that obstacle a few years ago by developing an improved method for sequencing the entire genomes of individual cells.

Single-cell whole-genome sequencing methods can introduce sequencing errors that are hard to distinguish from true mutations—a serious flaw when analyzing cells containing rare and random mutations.

Dr. Vijg solved this problem by developing a new sequencing technique called single-cell multiple displacement amplification (SCMDA). As reported in Nature Methods in 2017, this method accounts for and reduces sequencing errors.

The Einstein researchers used SCMDA to compare the mutational landscape of normal lung epithelial cells (i.e., cells lining the lung) from two types of people: 14 never-smokers, ages 11 to 86; and 19 smokers, ages 44 to 81, who had smoked a maximum of 116 pack years. One pack year of smoking equals 1 pack of cigarettes smoked per day for one year.

The cells were collected from patients who were undergoing bronchoscopy for diagnostic tests unrelated to cancer.

"These lung cells survive for years, even decades, and thus can accumulate mutations with both age and smoking," said Dr. Spivack. "Of all the lung's cell types, these are among the most likely to become cancerous."

Mutations Caused by Smoking

The researchers found that mutations (single-nucleotide variants and small insertions and deletions) accumulated in the lung cells of non-smokers as they age—and that significantly more mutations were found in the lung cells of the smokers. "This experimentally confirms that smoking increases lung cancer risk by increasing the frequency of mutations, as previously hypothesized," said Dr. Spivack. "This is likely one reason why so few non-smokers get lung cancer, while 10% to 20% of lifelong smokers do."

Effects of smoking cessation on mutation frequency: Median number of SNV and INDEL frequency among former smokers (n = 7) and current smokers (n = 12). a, each data point indicates the median value and the minimal and maximal range of SNV frequency of 3-8 nuclei per subject. b, each data point indicates the median value and the minimal and maximal range of INDEL frequency of 3-8 nuclei per subject. P values were obtained by likelihood ratio tests using negative binomial mixed-effect model. (CREDIT: Nature Methods)

Another finding from the study: The number of cell mutations detected in lung cells increased in a straight line with the number of pack years of smoking—and, presumably, the risk for lung cancer increased as well. But interestingly, the rise in cell mutations halted after 23 pack years of exposure.

"The heaviest smokers did not have the highest mutation burden," said Dr. Spivack. "Our data suggest that these individuals may have survived for so long in spite of their heavy smoking because they managed to suppress further mutation accumulation. This leveling off of mutations could stem from these people having very proficient systems for repairing DNA damage or detoxifying cigarette smoke."

The finding has led to a new research direction. "We now wish to develop new assays that can measure someone's capacity for DNA repair or detoxification, which could offer a new way to assess one's risk for lung cancer," said Dr. Vijg.

The Brighter Side of News, 29 September 2022

https://thebrighterside.news

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Clean hydrogen: A long-awaited solution for hard-to-abate sectors?

2022-09-29

One of the world's biggest climate challenges is decarbonizing fossil energy uses that cannot be directly electrified using renewable power. Among so-called "hard-to-abate" (HTA) sectors are major industries that rely on fossil fuels, either for high-temperature energy or for chemical feedstocks. These include iron and steel, cement, chemicals, and building materials, together responsible for approximately 30% of the world's annual CO2 emissions.

Another HTA sector is heavy-duty transportation such as trucking and shipping, which is harder to electrify than passenger transport because it would require enormous batteries that add to vehicle weight and take a long time to charge.

As countries examine pathways towards decarbonization, relatively wealthy ones like the U.S. and much of Europe are pursuing strategies focused on renewable power generation and electric vehicles. China faces significantly different challenges due to a distinctive carbon emission profile resulting from the much larger roles that HTA heavy industries play in its economy.

New research published in Nature Energy examines how China—by far the largest producer of iron, steel, cement, and building materials—can potentially utilize clean hydrogen ("green" and "blue" hydrogen) to decarbonize HTA sectors, and aid in achieving its 2030 and 2060 decarbonization pledges. Green hydrogen is made by splitting water molecules—H2O—using renewable electricity, while blue hydrogen is produced conventionally, from fossil fuels, but combined with carbon capture and storage.

The new paper from the Harvard-China Project on Energy, Economy and Environment, a U.S.-China collaborative research program based at the Harvard John A. Paulson School of Engineering and Applied Sciences, is the first study to date that uses an integrated modeling approach to evaluate the potential use of clean hydrogen across China's energy system and economy, in order to meet its 2060 net-zero target.

"Filling this research gap will help draw a clearer roadmap for China's CO2 emission reductions," explains lead author of the paper Xi Yang, a researcher at the Harvard-China Project. "Our goal with this study was to envision a role for clean hydrogen in China's energy economy, which can

Among so-called "hard-to-abate" (HTA) sectors are major industries that rely on fossil fuels, either for high-temperature energy or for chemical feedstocks.

then provide a reference for other developing economies with large heavy industrial and transportation sectors."

The study evaluated three questions: What are the key challenges of decarbonizing HTA sectors? What are the prospective roles for clean hydrogen as both an energy carrier and feedstock in HTA sectors? And would widespread application of clean hydrogen in HTA sectors be cost-effective compared to other options?

To analyze the cost-effectiveness and role of clean hydrogen across China's entire economy—with an emphasis on the under-researched HTA sectors—the team built a model of an integrated energy system that includes supply and demand across sectors. Results show that a widespread application of clean hydrogen in HTA sectors can help China achieve carbon neutrality cost-effectively compared to a scenario without clean hydrogen production and use. Clean hydrogen can save $1.72 trillion in investment costs and avoid a 0.13% loss in the aggregate GDP (2020-2060) compared to a pathway without it.

The researchers also examined the type of clean hydrogen—green or blue—that would be most cost effective. Their study indicates that the average cost of China's green hydrogen can be reduced to $2/kg of hydrogen by 2037 and $1.2/kg by 2050, when it will be much more cost-effective than blue hydrogen ($1.9/kg).

"China has rich untapped resources of solar and wind energy, both onshore and offshore," explains Chris P. Nielsen, co-author of the paper and Executive Director of the Harvard-China Project. "These resources give China advantages towards developing green hydrogen for use in its industrial and transportation sectors."

And while decarbonizing such hard-to-abate sectors is critical to climate action, it may have additional benefits. New markets for green hydrogen could also help the power system transition to renewable sources. Nielsen explains that green hydrogen production would do this by providing a comparatively flexible form of electricity demand that need not be met instantaneously, like most electricity loads. Instead it can often be scheduled, at least within short time frames. Such demand flexibility is valuable to grid managers, helping them to accommodate the inherent

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variability of renewable power sources as they are affected by changing meteorological conditions.

Tech Xplore, 29 September 2022

https://techxplore.com

Groundbreaking robotic pill eliminates the need for insulin injections

2022-10-03

One reason that it's so difficult to deliver large protein drugs orally is that these drugs can't pass through the mucus barrier that lines the digestive tract. This means that insulin and most other "biologic drugs" — drugs consisting of proteins or nucleic acids — have to be injected or administered in a hospital.

A new drug capsule developed at MIT may one day be able to replace those injections. The capsule has a robotic cap that spins and tunnels through the mucus barrier when it reaches the small intestine, allowing drugs carried by the capsule to pass into cells lining the intestine.

A new drug capsule developed at MIT can help large proteins such as insulin and small-molecule drugs be absorbed in the digestive tract.

"By displacing the mucus, we can maximize the dispersion of the drug within a local area and enhance the absorption of both small molecules and macromolecules," says Giovanni Traverso, the Karl van Tassel Career Development Assistant Professor of Mechanical Engineering at MIT and a gastroenterologist at Brigham and Women's Hospital.

In a study appearing today in Science Robotics, the researchers demonstrated that they could use this approach to deliver insulin as well as vancomycin, an antibiotic peptide that currently has to be injected.

Shriya Srinivasan, a research affiliate at MIT's Koch Institute for Integrative Cancer Research and a junior fellow at the Society of Fellows at Harvard University, is the lead author of the study.

Tunneling through

For several years, Traverso's lab has been developing strategies to deliver protein drugs such as insulin orally. This is a difficult task because protein drugs tend to be broken down in acidic environment of the digestive tract, and they also have difficulty penetrating the mucus barrier that lines the tract.

To overcome those obstacles, Srinivasan came up with the idea of creating a protective capsule that includes a mechanism that can tunnel through mucus, just as tunnel boring machines drill into soil and rock.

"I thought that if we could tunnel through the mucus, then we could deposit the drug directly on the epithelium," she says. "The idea is that you would ingest this capsule and the outer layer would dissolve in the digestive tract, exposing all these features that start to churn through the mucus and clear it."

The "RoboCap" capsule, which is about the size of a multivitamin, carries its drug payload in a small reservoir at one end and carries the tunnelling features in its main body and surface. The capsule is coated with gelatin that can be tuned to dissolve at a specific pH.

When the coating dissolves, the change in pH triggers a tiny motor inside the RoboCap capsule to start spinning. This motion helps the capsule to tunnel into the mucus and displace it. The capsule is also coated with small studs that brush mucus away, similar to the action of a toothbrush.

The spinning motion also helps to erode the compartment that carries the drug, which is gradually released into the digestive tract.

"What the RoboCap does is transiently displace the initial mucus barrier and then enhance absorption by maximizing the dispersion of the drug locally," Traverso says. "By combining all of these elements, we're really maximizing our capacity to provide the optimal situation for the drug to be absorbed."

Enhanced delivery

In tests in animals, the researchers used this capsule to deliver either insulin or vancomycin, a large peptide antibiotic that is used to treat a broad range of infections, including skin infections as well as infections affecting orthopedic implants. With the capsule, the researchers found that they could deliver 20 to 40 times more drug than a similar capsule without the tunneling mechanism.

Once the drug is released from the capsule, the capsule itself passes through the digestive tract on its own. The researchers found no sign of inflammation or irritation in the digestive tract after the capsule passed through, and they also observed that the mucus layer reforms within a few hours after being displaced by the capsule.

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Another approach that some researchers have used to enhance oral delivery of drugs is to give them along with additional drugs that help them cross through the intestinal tissue. However, these enhancers often only work with certain drugs. Because the MIT team's new approach relies solely on mechanical disruptions to the mucus barrier, it could potentially be applied to a broader set of drugs, Traverso says.

"Some of the chemical enhancers preferentially work with certain drug molecules," he says. "Using mechanical methods of administration can potentially enable more drugs to have enhanced absorption."

While the capsule used in this study released its payload in the small intestine, it could also be used to target the stomach or colon by changing the pH at which the gelatin coating dissolves. The researchers also plan to explore the possibility of delivering other protein drugs such as GLP1 receptor agonist, which is sometimes used to treat type 2 diabetes. The capsules could also be used to deliver topical drugs to treat ulcerative colitis and other inflammatory conditions by maximizing the local concentration of the drugs in the tissue to help treat the inflammation.

The research was funded, in part, by the National Institutes of Health and MIT's Department of Mechanical Engineering.

The Brighter Side of News, 3 October 2022

https://www.thebrighterside.news

The Impact of Aerosols – New Study Corrects Previous Research

2022-09-30

Cloud study clarifies the effects of aerosols.

According to a recent study, aerosol particles in the atmosphere have a greater influence on cloud cover than previously assumed, but less of an impact on cloud brightness. Aerosols, which are tiny particles floating in the atmosphere, are essential for the formation of clouds.

Numerous assessments by the Intergovernmental Panel on Climate Change (IPCC) have shown that since clouds reflect sunlight and maintain lower temperatures, aerosols, which are increasing as a result of human activity, might have a significant impact on climate change.

The findings could help improve climate change prediction models.

However, it is challenging to measure the cooling effect of aerosols on clouds, which has resulted in substantial uncertainty in climate change projections.

The new research, led by the University of Exeter in collaboration with national and international academic partners as well as the UK Met Office, investigated this using the 2014 Icelandic volcanic eruption.

"This massive aerosol plume in an otherwise near-pristine environment provided an ideal natural experiment to quantify cloud responses to aerosol changes, namely the aerosol's fingerprint on clouds," said lead author Dr. Ying Chen.

"Our analysis shows that aerosols from the eruption increased cloud cover by approximately 10%. Based on these findings, we can see that more than 60% of the climate cooling effect of cloud-aerosol interactions is caused by increased cloud cover. Volcanic aerosols also brightened clouds by reducing water droplet size, but this had a significantly smaller impact than cloud-cover changes in reflecting solar radiation."

Previous models and observations indicated this brightening accounted for the majority of the cooling caused by cloud-aerosol interactions.

Water droplets often develop in the atmosphere surrounding aerosol particles, so a larger concentration of these particles facilitates the formation of cloud droplets.

However, since these cloud droplets are smaller and more numerous, the resulting clouds may hold more water before rainfall occurs – hence, more aerosols in the atmosphere might result in greater cloud cover but less rain. The study used satellite data and computer learning to study cloud cover and brightness.

It used 20 years of satellite cloud images from two different satellite platforms from the region to compare the periods before and after the volcano eruption. The findings will provide observational evidence of aerosols' climate impacts to improve the models used by scientists to predict climate change.

Jim Haywood, Professor of Atmospheric Science at the University of Exeter and part of the Global Systems Institute, and a Met Office Research Fellow said: "Our earlier work had shown that model simulations could be used to disentangle the relative contribution of aerosol-cloud-climate impacts and potentially confounding meteorological variability."

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He continues, "This work is radically different as it does not rely on models; it uses state-of-the-art machine learning techniques applied to satellite observations to simulate what the cloud would look like in the absence of the aerosols. Clear differences are observed between the predicted and observed cloud properties which can be used to assess aerosol-cloud-climate impacts."

Sci Tech Daily, 30 September 2022

https://scitechdaily.com

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