CHEMWATCH

Bulletin Board

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DEC. 08, 2023

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ASIA PACIFIC

Urgent quarantine of sodium chloride 0.9% 10 mL and 30mL ampoules

2023-11-29

The Therapeutic Goods Administration (TGA) has issued a safety alert for sodium chloride 0.9% 10 mL ampoules and sodium chloride 0.9% 30 mL ampoules.

Affected product details:

Sodium chloride 0.9% 10 mL ampoules	**Sodium chloride 0.9% 30 mL ampoules**
Item number INTRPH-DMO200 CH2	Item number INTRPH-AIN001 CH2
Product code: 2048147	Product code: 2457101
Symbion product code: 107557	Symbion product code: 654299
Batches: 2304400, 2301530, 2301531 and 2207874	Batches: 2386043E, 2386048E, 2386051E and 2286030E

The TGA has identified that some batches of above-mentioned products were likely to have been used in a cluster of patients who tested positive for Ralstonia pickettii. The link between these cases and the Interpharma products has not yet been confirmed, therefore, the goods have not been recalled from the market at this time. As a precautionary measure, the TGA has quarantined these products until further notice.

Read More

APVMA, 29-11-23

https://www.apvma.gov.au/news-and-publications/news/urgent-quarantine-sodium-chloride-09-10-ml-and-30ml-ampoules

Japan to Ban PFHxS, Its Isomers and Their Salts

2023-11-30

Japan will prohibit the manufacture, import and use of PFHxS, its isomers, and their salts, and prohibit the import of certain products in which PFHxS, its isomers, or their salts are used.

Latest update:

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On November 28, 2023, the proposal was approved at a meeting of the government cabinet, which is expected to be officially published in the government gazette on December 1 of this year. The revisions remain unchanged from the consultation draft.

The effective dates will be:

- February 1, 2024: designation of PFHxS, its isomers or their salts as Class I Specified Chemical Substances
- June 1, 2024: addition of products to be prohibited from being imported, in which PFHxS, its isomers or their salts are used. In addition, the rules for fire extinguishers, fire-extinguishing agents and fire-extinguishing foam to comply with corresponding national technical standards and be properly labelled will be effective on June 1 2024.

On September 15, 2023, the Japanese Ministry of Health, Labour and Welfare (MHLW), Ministry of Economy, Trade and Industry (METI), and Ministry of Environment (MoE) issued a joint consultation regarding the designation of PFHxS, its isomers and their salts as Class I Specified Chemical Substances through a partial revision to the Enforcement Ordinance of the Chemical Substance Control Law (CSCL). Comments are welcome before October 14, 2023.

Once designated as Class I Specified Chemical Substances, the manufacture, import, and use of PFHxS, its isomers, and their salts will be prohibited in principle. Additionally, the import of certain products that contain these substances will also be prohibited. It is important to note that the decision on whether to ban PFHxS-related compounds is still under internal discussion and therefore not included in this proposed revision.

Read More

Chemlinked, 30-11-23

https://chemical.chemlinked.com/news/chemical-news/japan-to-ban-pfhxs-its-isomers-and-their-salts

Taiwan to Consolidate Duplicate Registration Applications of Same Substances

2023-11-30

Recently, Taiwan issued a notice requiring the same registrant to combine multiple applications for the same chemical substance into one, to prevent the evasion of higher quantity registration requirements through batch-wise submissions.

Substances applied for by the registrant himself, and substances applied for by a third-party representative (TPR) on behalf of the registrant cannot be duplicated. Registrants and third-party representatives should ensure that duplicate registrations are avoided, and prompt action is taken to consolidate and cancel registration codes for the same substances. According to the authority, accurate reporting of manufacturing and import quantities is crucial, and any discrepancies or upgrades in registration tonnage levels must be addressed through reapplication or supplementary information.

In addition, the registration platform will implement a new verification mechanism to prevent the submission of duplicate applications by TPR for the same substances under the same registrant.

Read More

Chemlinked, 30-11-23

https://chemical.chemlinked.com/news/chemical-news/taiwan-to-consolidate-duplicate-registration-applications-of-same-substances

AMERICA

Hexavalent Chromium in Drinking Water

2023-11-21

First Review Draft

The Office of Environmental Health Hazard Assessment (OEHHA) is announcing the availability of a draft document describing a proposed health-protective concentration (HPC) for noncancer effects of hexavalent chromium (Cr(VI)) in drinking water, as part of the update to the Cr(VI) Public Health Goal (PHG).

- First draft HPC Cr(VI) noncancer

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The comment period begins on November 24, 2023 and is scheduled to end on January 8, 2024. Also, on January 8, 2024 will host a public workshop on the draft technical document. More information on the workshop is in the link to the Notice below:

- First public review draft full notice
- Comment submissions – First draft of noncancer HPC for Cr(VI)

Read More

EHHA, 21-11-23

https://oehha.ca.gov/water/public-health-goal/hexavalent-chromium-drinking-water

Canada Gazette, Part I, Volume 157, Number 46: Certain Products Containing Toxic Substances Regulations

2023-11-18

REGULATORY IMPACT ANALYSIS STATEMENT

General Comment

Add a comment for the General Comment section

Issues

In 2021, the Department of the Environment and the Department of Health (the Departments) concluded that coal tars and their distillates, hereinafter referred to as coal tars, are toxic to human health and the environment under section 64 of the Canadian Environmental Protection Act, 1999 (CEPA), and proposed adding these substances to Schedule 1 to CEPA.footnote1 Adding these substances to Schedule 1 would allow the Minister of the Environment and the Minister of Health to take measures, including regulatory measures, to prevent their release into the environment. These substances constitute a risk to human life or health in Canada, as they are entering the environment under conditions that have an immediate or long-term harmful effect on the environment and its biological diversity.

During consultations on proposed regulations for coal tar-based sealant products, comments were received identifying additional risk management needs for possible replacement products to coal tar-based sealant products, which contain high levels of polycyclic aromatic hydrocarbons (PAHs). An assessment published in 1994 concluded that PAHs, as a class, are toxic under CEPA, resulting in the addition of PAHs

to Schedule 1 to CEPA in 1999. Currently, risk management instruments for PAHs do not address potential concerns from pavement and roofing sealants. Therefore, there is a need to regulate sealants containing PAHs with a combined content above 1 000 parts per million (ppm) to mitigate the risk of substitution with alternatives that may also pose a risk to human health and the environment following the prohibition of coal tar-based sealants.footnote2 Regulations are needed to prohibit the manufacture and import of coal tar-based sealants and to limit the use of PAHs in these sealants to protect human health and the environment.

Read More

Canada Gazette, 18-11-23

https://www.gazette.gc.ca/rp-pr/p1/2023/2023-11-18/html/reg3-eng.html

Unpacking New EPA Requirements on 'Forever Chemicals'

2023-11-28

The EPA has finalized its enhanced reporting requirement for substances commonly known as "forever chemicals." Assent's Cally Edgren digs into the widespread effects for companies that make or sell manufactured goods,

In October, the EPA published its final rule regarding reporting obligations for manufacturers and importers of per- and polyfluoroalkyl substances (PFAS), more commonly referred to as "forever chemicals." The new rule, under Section 8(a)(7) of the Toxic Substances Control Act (TSCA), requires manufacturers to report the manufacture and/or import of PFAS chemicals to the EPA for each year dating back to 2011.

This includes PFAS in imported "articles," such as in a surface coating or electrical insulation). These reports must include complex information, including PFAS identity, categories of use and production or import volumes. The EPA estimates that at least 1,462 chemicals are "PFAS," according to the definition of this rule, half of which are actively used in the U.S. market.

Final reports for most manufacturers and importers must be submitted by May 8, 2025 (small manufacturers may be allowed an additional six months).

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Corporate Compliance Insights, 28-11-23

https://www.corporatecomplianceinsights.com/unpacking-epa-forever-chemicals/

Changes to TRI Reporting Requirements for Per- and Polyfluoroalkyl Substances and to Supplier Notifications for Chemicals of Special Concern

2023-11-30

Changes to TRI Reporting Requirements for Per- and Polyfluoroalkyl Substances and to Supplier Notifications for Chemicals of Special Concern

Rule Summary

EPA added per- and polyfluoroalkyl substances, or PFAS, subject to reporting under the Emergency Planning and Community Right-to-Know Act and the Pollution Prevention Act pursuant to the National Defense Authorization Act for Fiscal Year 2020 to the list of Lower Thresholds for Chemicals of Special Concern (chemicals of special concern).

These PFAS are subject to the same reporting requirements as other chemicals of special concern. They are no longer eligible for use of the de minimis exemption or the option for facilities to use the reporting Form A, and are also subject to limits on range reporting.

This rule will result in a more complete picture of the releases and waste management quantities for these PFAS.

The rule also makes the de minimis exemption unavailable for purposes of supplier notification requirements to downstream facilities for all chemicals on the list of chemicals of special concern, which also includes certain persistent, bioaccumulative and toxic chemicals like lead, mercury, and dioxins. This change helps ensure that purchasers of mixtures and trade name products containing these chemicals are informed of their presence in mixtures and products they purchase.

Because PFAS are used at low concentrations in many products, the elimination of the de minimis exemption will result in a more complete picture of the releases and other waste management quantities for these chemicals.

Read More

US EPA, 30-11-23

https://www.epa.gov/toxics-release-inventory-tri-program/changes-tri-reporting-requirements-and-polyfluoroalkyl

U.S. EPA Proposes to Revise Regulations for DecaBDE and PIP 3:1 under TSCA

2023-11-24

The revision would impose workplace safety protection, water release restriction, affecting a broad range of industries including the nuclear energy sector, transportation, construction, agriculture, forestry, mining, life sciences, and semiconductor production.

The U.S. Environmental Protection Agency (EPA) has initiated proposals to revise the regulations for decabromodiphenyl ether (decaBDE) and phenol, isopropylated phosphate (3:1) (PIP (3:1)), two of the five persistent, bioaccumulative, and toxic (PBT) chemicals addressed in final rules issued under the Toxic Substances Control Act (TSCA) in January 2021. The proposed rules intend to further reduce exposures to these two PBT chemicals to better protect human health and the environment. Comments shall be submitted to EPA within 45 days after date of publication in the Federal Register.

As required under TSCA, EPA issued final rules concerning five PBT chemicals on January 6, 2021. In addition to decaBDE and PIP 3:1, the other three are 2,4,6-Tris(tert-butyl) phenol (2,4,6-TTBP), hexachlorobutadiene (HCBD), and pentachlorothiophenol (PCTP). The final rules identified uses, hazards and risk management actions for each of the five PBT chemicals.

Following issuance of Executive Order 13990 (Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis), EPA announced its plan to review the five final rules issued on January 6, 2021 after receiving comments on additional actions that could be taken to reduce exposures to these PBT chemicals to the extent practicable.

Read More

Chemlinked, 24-11-23

https://chemical.chemlinked.com/news/chemical-news/us-epa-consults-on-revising-regulations-for-decabde-and-pip-31-under-tsca

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EUROPE

Council adopts position on digital labelling in the fertilisers sector

2023-11-17

The Council has today adopted its position ('negotiating mandate') on the proposed regulation on digital labelling of EU fertilising products. This proposal, which amends regulation (EU) 2019/1009, aims to improve the readability of labels, leading to a more efficient use of fertilising products, and to simplify the labelling obligations for suppliers while reducing costs for the industry.

While the Council's position shares the main objectives of the amended regulation, it introduces several improvements in an attempt to strike the right balance between moving towards the digitalisation of labels for economic operators and the prevention of potential information problems for end-users, taking into consideration digital skills and connectivity limitations that some farmers may face.

Commission proposal

Labelling of fertilisers is currently regulated by regulation (EU) 2019/1009. The revision of this legislation proposes allowing suppliers of fertilising products to communicate labelling information in a physical format, a digital format, or a combination of the two. The Commission's text proposes that a digital-only format will be allowed when the EU fertilising products are sold without packaging or when the products are sold to economic operators who are not end-users of the products.

Farmers and other consumers of fertilising products sold in packaging would continue to benefit from both digital and physical labels for the most important information (i.e. health and environmental protection, agronomic efficiency or contents). The Commission's proposal prescribes the content and the technological requirements for digital labels. The economic operators would have to ensure that the digital label will be searchable, accessible, free of charge and capable of meeting the needs of vulnerable groups. The Commission would be empowered to update the general digital labelling.

Read More

Council of the EU, 17-11-23

https://www.consilium.europa.eu/en/press/press-releases/2023/11/17/council-adopts-position-on-digital-labelling-in-the-fertilisers-sector/

Waste shipments: Council and Parliament reach agreement on more efficient and updated rules

2023-11-17

The Council and the European Parliament's negotiators today reached a provisional political agreement to update the regulation on shipments of waste.

The revision of the regulation aims to reduce shipments of problematic waste to outside the EU, update shipment procedures to reflect the objectives of the circular economy and improve enforcement.

It sets procedures and control regimes to ensure that international shipments of waste do not pose a threat to human health and the environment, and to promote the use of waste as a resource in a circular economy within the EU.

The deal is provisional pending formal adoption by both institutions.

Scope and objectives of the regulation

The co-legislators agreed to expand the objectives of the regulation to include climate neutrality and the achievement of the circular economy and zero pollution.

The agreement covers intra-EU shipments of waste (with or without transit through third countries), imported and exported waste from and to third countries, and waste shipments in transit through the EU to or from third countries.

Intra-EU shipments

The text bans the shipments of all waste destined for disposal within the EU, except if consented to and authorised under the strict conditions of the prior written notification and consent procedure ('PIC') and in well-justified cases. On the other hand, intra-EU shipments of waste for recovery operations will continue to be allowed following the less stringent procedure set out in the general information requirements ('green-listed waste').

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Read More

Council of the EU, 17-11-23

https://www.consilium.europa.eu/en/press/press-releases/2023/11/17/waste-shipments-council-and-parliament-reach-agreement-on-more-efficient-and-updated-rules

New EU rules encouraging consumers to repair devices over replacing them

2023-11-21

Parliament adopted its negotiating position on new measures to strengthen the right to repair and reduce the environmental impact of mass consumption.

On Tuesday, Parliament adopted its position on a stronger "right to repair" for consumers, with 590 votes in favour, 15 against, and 15 abstentions. The proposal aims to encourage more sustainable consumption, by making it easier to repair defective goods, reducing waste and supporting the repair sector.

Choose repair instead of buying, even after the guarantee expires

Within the legal guarantee period, sellers would be required to prioritise repair if it is cheaper or equal in cost to replacing a good, unless the repair is not feasible or inconvenient for the consumer. MEPs also propose to extend the legal guarantee by one year once a product has been fixed.

Consumers will have a right to request repair for products such as washing machines, vacuum cleaners, smartphones and bicycles after the guarantee has expired. To make repairs the more attractive choice for consumers, MEPs want producers to offer replacement devices on loan for the duration of the repair. If a product cannot be fixed, a refurbished one could be offered instead.

More competitive repair market and incentives to opt for repair

Consumers are often discouraged from having a product repaired due to high costs, the difficulty of accessing repair services or design features preventing repair. Under Parliament's position, independent repairers, refurbishers and end-users would have access to all spare parts, repair information, and tools at a reasonable cost.

Online platforms will help consumers find local repairers (including repair cafés) and sellers of refurbished goods in their area. To make repairs more affordable and attractive, MEPs propose offering consumers vouchers and other financial incentives via national repair funds.

Read More

Europena Parliament, 21-11-23

https://www.europarl.europa.eu/news/en/press-room/20231117IPR12211/new-eu-rules-encouraging-consumers-to-repair-devices-over-replacing-them

New regulation on the protection of European craft and industrial products enters into force

2023-11-16

The Craft and Industrial Geographical Indication (CIGI) Regulation enters into force today. It marks a significant milestone in the protection of the names of European craft and industrial products that rely on the originality and authenticity of traditional skills from their regions.

The Regulation will harmonise the protection of valuable European craft and industrial products, such as Limoges porcelain, Solingen knives, Carrara marble, or Madeira embroidery.

Protecting craft and industrial products at EU level

Unified EU-Wide Protection: Names of craft and industrial products that meet the necessary requirements for CIGI protection will now be safeguarded at the EU level through a single registration that covers the entire EU territory. Previously, for instance, producers of 'Burgundy stone' had to register their Geographical Indication in each EU Member State, if available, to combat infringements. With the CIGI Regulation, craft and industrial producers can now obtain protection in all 27 EU Member States with just one Geographical Indication registration.

Examination and registration: This will be done in two phases: Producers will first file their Geographical Indication applications to designated Member States' authorities, who will then submit successful applications for further evaluation and approval to the European Union Intellectual Property Office (EUIPO). A direct application procedure to EUIPO will also be possible for Member States that obtain a derogation from the Commission, if they have no national evaluation procedure in place or lack

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interested producers. The Commission will retain the possibility to decide on a Geographical Indication application in certain cases.

Prominent Geographical Indication Labelling: Craft and industrial producers will have the opportunity to showcase their protected Geographical Indication names by displaying a distinct logo on their products. This labelling will enable consumers to identify Craft and Industrial products with specific characteristics linked to their geographical origin, helping them make informed choices when purchasing these products.

Read More

European Commission, 16-11-23

https://ec.europa.eu/commission/presscorner/detail/en/ip_23_5813

INTERNATIONAL

UNECE calls on fashion industry to fully embrace sustainability

2023-10-27

Clothing production has doubled in the past 15 years. In 2018, the fashion industry produced around 2.1 billion tons of greenhouse gas emissions (GHG) – 4% of the world's total – leading to major environmental, health and social challenges. In 2020 in Europe, textile consumption had the third highest impact on water and land use.

Given this context, fashion industry leaders have a critical responsibility and a vital role to play to reduce their GHG emissions and ensure that the Sustainable Development Goals (SDGs) are integrated in their operations and business models. However, the current level of supply chain transparency in the sector is very low, reminded UNECE Executive Secretary Tatiana Molcean at the Venice Sustainable Fashion Forum 2023.

A transparent and sustainable fashion industry is a shared responsibility of businesses and policymakers and can only be achieved through cooperation of all stakeholders, including consumers. Surveys show that 40-60% consumers would be ready to pay more for products with better environmental performance and want to make more sustainable choices. But this is not yet reflected in the sales of fast fashion companies.

As a global convening platform to support policy coherence and alignment across sectors, UNECE has a key role to play to support sustainability and traceability. Through consultation with hundreds of industry insiders and experts, UNECE has developed a UN-brokered toolbox to help garment and footwear makers to ensure the transparency and traceability of their value chain. The resulting initiative, called The Sustainability Pledge, encourages companies across the sector to announce their commitments to transparency and traceability.

"We engaged with approximately 100 companies across 23 countries to demonstrate the traceability of 19 fashion products across the full spectrum of the value chain, from cooperatives and producers to manufacturers, tanneries, and brands," Ms. Molcean said. "What we need now is the application of these results at scale across the industry through concrete actions. I call on all players in the industry to join this collective effort and take concrete measures to improve traceability and transparency, share relevant information with customers and thus move the needle towards sustainable fashion."

Read More

UNECE, 27-10-23

https://unece.org/circular-economy/news/unece-calls-fashion-industry-fully-embrace-sustainability

Third round of UN plastics treaty negotiations conclude

2023-11-29

On November 19, 2023, the third round of negotiations by the United Nations Intergovernmental Negotiating Committee on Plastic Pollution (INC) concluded. Diplomats from countries across the globe convened to negotiate alongside observers including scientists, industry representatives, activists, youth organizations, and others in Nairobi, Kenya. On the ground throughout the entire week were 37 members of the Scientist's Coalition for an Effective Plastics Treaty, a diverse group of leading experts on plastic pollution research including two team members from the Food Packaging Forum.

As an outcome of the meeting, the INC secretariat has been tasked with revising the Zero Draft by the end of the year based on the input received by Committee members during the meeting. The document outlines all of the options proposed for addressing plastic pollution across the entire life span of plastics. The negotiations will reconvene at the Committee's

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fourth meeting on April 21 – 30, 2024, in Ottawa, Canada. Despite a clear interest by many members in establishing intersessional work to prepare key documents, there was no consensus on a mandate for such work before the next round of negotiations in April. This lack of progress raised concerns from many about the Committee's ability to realistically achieve an effective global plastics treaty by the planned end of the process next year.

During the INC-3 meeting, three contact groups focused on discussing different aspects of the Zero Draft, with final updates from Group 1 and Group 2 indicating disagreement and a wide range of proposed approaches to address the complexity involved. Group 3 was unable to finish its discussions and provide an updated version of the draft text. Contact Group 1 focused on the technical and regulatory elements within the Zero Draft, Group 2 on financial, implementation, and compliance aspects, and Group 3 on institutional arrangements and general and final provisions not covered during the INC-2 meeting. There is an updated version of the Zero Draft already available that contains the revisions from Groups 1 and 2, and the final revised Zero Draft that contains input from Group 3 is expected to be over 100 pages long once published at the end of this year. This is a significant increase in the length of the draft (compared to the start of the INC-3 meeting), and it will serve as the basis for the continued negotiations in Ottawa next April.

Read More

FPF, 29-11-23

https://www.foodpackagingforum.org/news/third-round-of-un-plastics-treaty-negotiations-conclude

ECHA identifies risks from PVC additives and microparticle releases

2023-11-28

The European Chemicals Agency's (ECHA) investigation found that some substances added to polyvinyl chloride (PVC) plastic, like plasticisers, may pose risks to people and the environment. To limit the use of these additives and to minimise releases of PVC microparticles, regulatory action would be necessary.

Helsinki, 28 November 2023 – ECHA collected, as requested by the European Commission, information on the potential risks of PVC additives and PVC itself to human health and the environment. It also considered possible alternatives and assessed the societal impacts of potential risk management measures.

The investigation focused on 63 PVC additives, including plasticisers, heat stabilisers and flame retardants. The key findings suggest that regulatory action would be needed:

- to minimise risks associated with plasticisers, particularly certain ortho-phthalates, which are harmful to reproduction;
- to minimise risks from heat stabilising organotins, such as DOTE, which may cause developmental malformations and reproductive harm;
- to reduce emissions of flame retardants as suggested in ECHA's Regulatory Strategy for Flame Retardants; and
- to implement and improve technologies that minimise PVC microparticle emissions especially at recycling facilities and landfills. The release of PVC microparticles contributes to plastic pollution. These microparticles also contain harmful additives, and therefore, minimising their releases would consequently reduce emissions of these additives.

The risks from PVC resin to workers and the environment are considered adequately controlled with the current operational conditions and companies' safety measures. This conclusion followed an analysis of the materials used in making PVC resin, the production process, waste disposal and exposure to PVC dust.

ECHA's investigation has now been sent to the European Commission, which will assess it and decide whether there is a need to formally ask ECHA to prepare a REACH restriction proposal.

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ECHA, 28-11-23

https://echa.europa.eu/completed-activities-on-restriction

Janet's Corner

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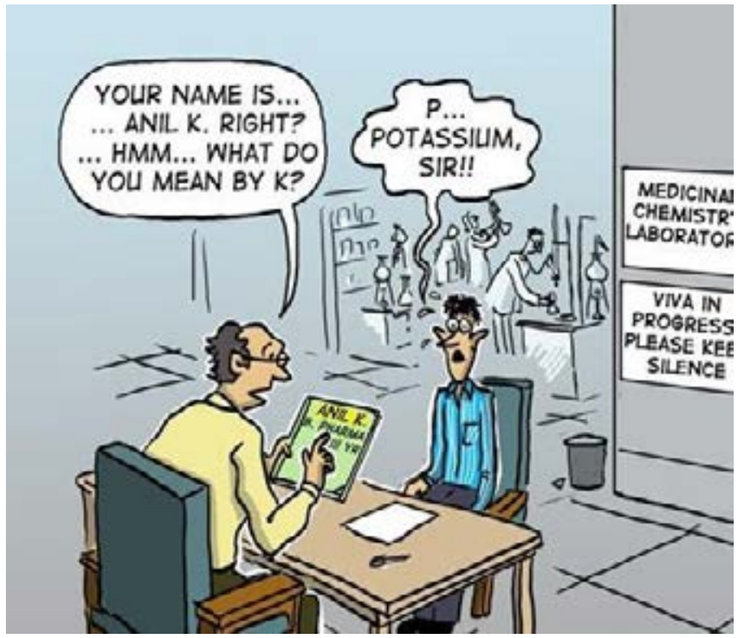
Potassium Sir!

2023-12-08



https://chemistryiit.wordpress.com/typical-chemistry-jokes/

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Hazard Alert

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Hydrogen Peroxide

2023-12-08

USES [2,3]

Industrial

- Hydrogen peroxide is used for pulp- and paper-bleaching.
- It is also used in the manufacture of sodium percarbonate and sodium perborate, which are used as mild bleaches in laundry detergents.
- Hydrogen peroxide is used in the production of various organic peroxides including dibenzoyl peroxide, which are used as a flour bleaching agent and as a treatment for acne.
- Peroxy acids, such as peracetic acid and meta-chloroperoxybenzoic acid are also typically produced using hydrogen peroxide.
- Hydrogen peroxide is used in certain waste-water treatment processes to remove organic impurities.

Medical

Disinfectant

- Hydrogen peroxide can be used for the sterilisation of various surfaces, including surgical tools and may be deployed as a vapour (VHP) for room sterilisation.
- Historically hydrogen peroxide was used for disinfecting wounds. It is now thought to slow healing and lead to scarring because it destroys newly formed skin cells.

Cosmetic applications

Diluted hydrogen peroxide (between 1.9% and 12%) mixed with ammonium hydroxide is used to bleach human hair.

Hydrogen peroxide is also used for tooth whitening and can be mixed with baking soda and salt to make a home-made toothpaste.

Hydrogen peroxide may be used to treat acne, although benzoyl peroxide is a more common treatment.

Propellant

Hydrogen peroxide is a component of rocket fuel.

Hydrogen peroxide is a chemical compound with the formula H_2O_2. [1] It is a colourless liquid at room temperature with a bitter taste.

Explosives

Hydrogen peroxide has been used for creating organic peroxide-based explosives, such as acetone peroxide, for improvised explosive devices.

Other uses

Glow sticks: Hydrogen peroxide reacts with certain di-esters, such as phenyl oxalate ester (cyalume), to produce chemiluminescence; this application is most commonly encountered in the form of glow sticks.

Horticulture

Some horticulturalists and users of hydroponics advocate the use of weak hydrogen peroxide solution in watering solutions. Its spontaneous decomposition releases oxygen that enhances a plant's root development and helps to treat root rot (cellular root death due to lack of oxygen) and a variety of other pests.

Fish aeration

Laboratory tests conducted by fish culturists in recent years have demonstrated that common household hydrogen peroxide can be used safely to provide oxygen for small fish. The hydrogen peroxide releases oxygen by decomposition when it is exposed to catalysts such as manganese

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- You can be exposed to hydrogen peroxide through its use as a general disinfectant. Hydrogen peroxide solutions used for this purpose are sold at almost all drugstores or supermarkets.
- Because hydrogen peroxide is used in many industries for a variety of purposes, workers in such industries may be exposed to this chemical through inhalation or contact with the skin.

Routes of Exposure

- Inhalation: Inhalation of vapours, mists, or aerosols from concentrated solutions of hydrogen peroxide can cause significant morbidity. Because it is nearly odourless and non-irritating except at high concentrations, persons may not be aware of its presence.
- Skin/Eye Contact: Hydrogen peroxide is poorly absorbed through intact skin. When used for household disinfectant purposes (3% to

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5%), it is mildly irritating to the skin and mucous membranes. At a concentration of 10%, which is found in some hair-bleaching solutions, it is strongly irritating and may be corrosive.

- Ingestion: If ingested, solutions of hydrogen peroxide up to concentrations of 9% are generally nontoxic; however, even a 3% solution is mildly irritating to mucosal tissue and may cause vomiting and diarrhoea. Ingestion of industrial-strength solutions causes systemic toxicity and has been associated with fatalities.

HEALTH EFFECTS [4]

Acute Health Effects

- Hydrogen peroxide can be toxic if ingested, inhaled, or by contact with the skin or eyes.
- Inhalation of household strength hydrogen peroxide (3%) can cause respiratory irritation.
- Exposure to household strength hydrogen peroxide can cause mild ocular irritation.
- Inhalation of vapours from concentrated (higher than 10%) solutions may result in severe pulmonary irritation.
- Ingestion of dilute solutions of hydrogen peroxide may result in vomiting, mild gastrointestinal irritation, gastric distension, and on rare occasions, gastrointestinal erosions or embolism (blockage of blood vessels by air bubbles). Ingestion of solutions of 10-20% strength produces similar symptoms, but exposed tissues may also be burned. Ingestion of even more concentrated solutions, in addition to the above, may also induce rapid loss of consciousness followed by respiratory paralysis.
- Eye exposure to 3% hydrogen peroxide may result in pain and irritation, but severe injury is rare. More concentrated solution may result in ulceration or perforation of the cornea.
- Skin contact can cause irritation and temporary bleaching of the skin and hair. Contact with concentrated solutions may cause severe skin burns with blisters.
- It is unknown whether hydrogen peroxide affects in humans.

SAFETY

First Aid Measures [5]

- 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: 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 if symptoms appear.

Workplace Controls & Practices [4]

Control measures include:

- Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value.
- Ensure that eyewash stations and safety showers are proximal to the work-station location.

The following work practices are also recommended:

- Label process containers.
- Provide employees with hazard information and training.

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- Monitor airborne chemical concentrations.
- Use engineering controls if concentrations exceed recommended exposure levels.
- Provide eye wash fountains and emergency showers.
- Wash or shower if skin comes in contact with a hazardous material.
- Always wash at the end of the workshift.
- Change into clean clothing if clothing becomes contaminated.
- Do not take contaminated clothing home.
- Get special training to wash contaminated clothing.
- Do not eat, smoke, or drink in areas where chemicals are being handled, processed or stored.
- Wash hands carefully before eating, smoking, drinking, applying cosmetics or using the toilet.

Personal Protective Equipment [5]

The following personal protective equipment is recommended when handling hydrogen peroxide:

- Face shield;
- Full suit;
- Vapour respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves;
- Boots.
- Personal Protection in Case of a Large Spill:
- Splash goggles;
- Full suit;
- Vapour 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.

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REGULATION

United States

OSHA: The Occupational Safety & Health Administration has set the following Permissible Exposure Limits (PEL) for hydrogen peroxide:

- General Industry: 29 CFR 1910.1000 Table Z-1 -- 1 ppm, 1.4 mg/m3 TWA
- Construction Industry: 29 CFR 1926.55 Appendix A -- 1 ppm, 1.4 mg/m3 TWA
- Maritime: 29 CFR 1915.1000 Table Z-Shipyards -- 1 ppm, 1.4 mg/m3 TWA

ACGIH: The American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for hydrogen peroxide of 1 ppm, 1.4 mg/m3 TWA; Appendix A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans

NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) for hydrogen peroxide of 1 ppm, 1.4 mg/m3 TWA

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Suite of Genes Influence Head Shape in Humans

2023-11-20

Researchers at the University of Pittsburgh and KU Leuven have discovered a suite of genes that influence head shape in humans. These findings, published this week in Nature Communications, help explain the diversity of human head shapes and may also offer important clues about the genetic basis of conditions that affect the skull, such as craniosynostosis.

By analyzing measurements of the cranial vault — the part of the skull that forms the rounded top of the head and protects the brain — the team identified 30 regions of the genome associated with different aspects of head shape, 29 of which have not been reported previously.

"Anthropologists have speculated and debated the genetics of cranial vault shape since the early 20th century," said co-senior author Seth Weinberg, Ph.D., professor of oral and craniofacial sciences in the Pitt School of Dental Medicine and co-director of the Center for Craniofacial and Dental Genetics. "We knew from certain rare human conditions and animal experiments that genes play an important role in vault size and shape, but very little was known about the genetic basis for typical features we see in the general population, such as what makes someone's head long and narrow versus short and wide. This study reveals some of the key genes driving variation in this part of the human body."

According to the researchers, one application of better understanding the factors that drive natural variation in human head shape is informing paleoanthropology studies, potentially shedding light on the early development of modern humans.

Weinberg and colleagues used magnetic resonance (MR) scans from more than 6,000 adolescents to extract 3D surfaces corresponding to the cranial vault. After dividing the 3D vault surfaces into incrementally smaller anatomical subparts and quantifying the shape of these subparts, they tested more than 10 million genetic variants for evidence of statistical association with measures of vault shape.

"Previous genetic studies of the cranial vault involved a small number of relatively simple measures," added Weinberg. "While such measures are often easy to obtain, they may fail to capture features that are biologically relevant. Our analysis used an innovative approach capable of describing 3D vault shape in much more comprehensive and nuanced ways. This approach increased our ability to find genetic associations."

Researchers have identified a suite of genes that influence head shape in humans, helping to explain head shape diversity.

An important discovery was that many of the strong associations are near genes that play key roles in the early formation of the head and face and regulation of bone development. For example, variants in and near the gene RUNX2, a major player in coordinating development of the skull, were associated with multiple aspects of vault shape.

While some genes, including RUNX2, had global effects involving the entire vault, others showed more localized effects that only impacted a specific portion of the vault, such as the central forehead.

Technology Networks, 20 November 2023

https://technologynetworks.com

Identifying vintage wines by their chemical signature

2023-12-05

These results, published in the journal Communications Chemistry, pave the way for potential new tools to combat counterfeiting and for predictive tools to guide decision-making in the wine sector.

Every wine is the result of fine, complex mixtures of thousands of molecules. Their concentrations fluctuate according to the composition of the grapes, which depends in particular on the nature and structure of the soil, the grape variety and the winegrower's practices.

These variations, even very small ones, can have a big impact on the taste of wine. This makes it very difficult to determine the precise origin of a wine based on this sensory criterion alone. With climate change, new consumer habits and an increase in counterfeiting, the need for effective tools to determine the identity of wines has become crucial.

Is there then a chemical signature, invariable and specific to each estate, that would make it possible to do this? "The wine sector has made numerous attempts to answer this question, with questionable or sometimes correct results but involving heavy techniques. This is due to the great complexity of the blends and the limitations of the methods used, which are a bit like looking for a needle in the middle of a haystack," explains Alexandre Pouget, full professor in the Department of Basic Neurosciences in the Faculty of Medicine at UNIGE.

One of the methods used is gas chromatography. This consists in separating the components of a mixture by affinity between two materials. The mixture passes through a very thin tube, 30 meters long.

Does every wine carry its own chemical signature and, if so, can this be used to identify its origin? Many specialists have tried to solve this mystery, without fully succeeding.

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The components that have the greatest affinity with the tube material gradually separate from the others.

Each separation is recorded by a mass spectrometer. A chromatogram is then produced, showing peaks that indicate the molecular separations. In the case of wine, because of the many molecules that make it up, these peaks are extremely numerous, making detailed and exhaustive analysis very difficult.

Data processed by machine learning

In collaboration with Stephanie Marchand's team from the Institute of Vine and Wine Science at the University of Bordeaux, Alexandre Pouget's team found the solution by combining chromatograms and artificial intelligence tools. These chromatograms came from 80 red wines from twelve vintages (1990–2007) and from seven estates in the Bordeaux region. This raw data was processed using machine learning, a field of artificial intelligence in which algorithms learn to identify recurring patterns in sets of information.

"Instead of extracting specific peaks and deducing concentrations, this method allowed us to take into account each wine's complete chromatograms—which can comprise up to 30,000 points—including background noise, and to summarize each chromatogram into two X and Y coordinates, after eliminating unnecessary variables. This process is called dimensionality reduction," explains Michael Schartner, a former postdoctoral scholar in the Department of Basic Neurosciences in the Faculty of Medicine at UNIGE, and first author of the study.

A 100% reliable model

By placing the new coordinates on a graph, the researchers were able to see seven "clouds" of points. They found that each of these clouds grouped together vintages from the same estate on the basis of their chemical similarities.

"This allowed us to show that each estate does have its own chemical signature. We also observed that three wines were grouped together on the right and four on the left, which corresponds to the two banks of the Garonne on which these estates are located," explains Stéphanie Marchand, a professor at the Institute of Vine and Wine Science at the University of Bordeaux, and co-author of the study.

Throughout their analyses, the researchers found that the chemical identity of these wines was not defined by the concentration of a few specific molecules, but by a broad chemical spectrum. "Our results show

that it is possible to identify the geographical origin of a wine with 100% accuracy, by applying dimensionality reduction techniques to gas chromatograms," says Alexandre Pouget, who led this research.

This research provides new insights into the components of a wine's identity and sensory properties. It also paves the way for the development of tools to support decision-making—to preserve the identity and expression of a terroir, for example—and to combat counterfeiting more effectively.

Phys Org, 05 December 2023

https://phys.org

Under-skin implant reverses type 1 diabetes without anti-rejection drugs

2023-11-05

In type 1 diabetes, the body's immune system attacks and destroys the insulin-producing cells of the pancreas, called islet cells, preventing the secretion of insulin and necessitating the lifelong administration of insulin injections or the use of an insulin pump.

Researchers from Cornell University and the University of Alberta (U of A) collaborated to create an under-the-skin implant that secretes insulin while avoiding the immune reactions implanted devices can produce.

"Over the years, I receive a lot of emails and requests from parents and patients saying, 'Hey, my baby was diagnosed with type 1 [diabetes], can you help us?'" said Minglin Ma, one of the study's corresponding authors. "It's a very bad disease, and a lot of children have it. So, we are really serious about pushing this into something clinically applicable, something that's impactful."

In 2017, Ma, from Cornell's College of Agriculture and Life Sciences (CALS), developed the Thread-Reinforced Alginate Fiber For Islets enCapsulation (TRAFFIC), a removable nylon thread implant containing hundreds of thousands of islet cells protected by a thin alginate hydrogel coating and inserted into the abdominal cavity. A more robust version of the implant was created in 2021 that effectively controlled blood sugar in mice for up to six months.

Ma's implant attracted the attention of U of A diabetes researcher James Shapiro, who'd created a method for inserting islet cells in channels just under the skin and then applying immunosuppression to protect them.

Researchers have developed a technique to implant a thread-like device containing insulin-secreting pancreatic cells in a pocket under the skin.

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"I was intrigued by the virtue of Ma's approach as it avoided the need for immunosuppression, and I wondered if we might combine our two innovative strategies to improve cell survival," Shapiro, the study's other corresponding author, said. "And indeed, it worked! By combining the two it really did improve the skin site for engrafting cells without the need for anti-rejection drugs."

The resulting collaboration produced SHEATH, the Subcutaneous Host-Enabled Alginate THread.

SHEATH implantation is a two-step process. First, a medical-grade nylon catheter is inserted under the skin, where it remains for four to six weeks. The catheter triggers a controlled foreign-body inflammatory response that causes a dense network of blood vessels to form around it. When the catheters are removed, the alginate-based islet cell-seeded device is inserted into the pocket – or channel – that's been created, with the surrounding vessels providing the islet cells with the required oxygen and nutrients.

"That channel is a perfect fit for our device," Ma said. "Shapiro used the analogy that this is like a hand in a glove. And putting something under your skin is much easier, much less invasive than in the abdomen. It can be done as an outpatient procedure, so you don't have to stay in hospital. It can be done under local anesthesia."

Implanting the SHEATH system in diabetic mice led to a reversal of the condition without the need for immunosuppression. Experiments showed a robust capacity for long-term diabetes reversal, with some mice achieving correction of high blood glucose for over 190 days. Moreover, the system allowed for the removal and replacement of a failing implant, indicated by rising blood glucose levels. After being replaced with a fresh implant, blood glucose levels returned to normal.

Confirming the system's scalability, the researchers successfully developed procedures to implement the SHEATH approach in minipigs, including insertion, removal, and replacement of the implant.

The researchers acknowledge that, despite the SHEATH system's promising features, additional challenges regarding its clinical utility need to be overcome. Specifically, determining an acceptable catheter length and identifying anatomically appropriate sites for placement.

"The challenge is, it's very difficult to keep these islets functional for a long time inside of the body where you have a device because the device

blocks the blood vessels, but the native islet cells in the body are known to be in direct contact with vessels that provide nutrients and oxygen," said Ma. "The device is designed in a way that we can maximize the mass exchange of nutrients and oxygen, but we may need to provide additional means to support the cells for a long-term function in large-animal models and eventually patients."

These 'additional means' may include incorporating a continuous oxygen supply into the device. Ma has formed a new Cornell spin-off, Persista Bio, to develop a separate device to supply additional oxygen to the cells.

Despite these challenges, the researchers are hopeful that future versions of the implant device will be able to last for two to five years before needing to be replaced.

The study was published in the journal Nature Biomedical Engineering.

New Atlas, 05 December 2023
https://newatlas.com

Carbon-free fuels could have a dark side

2023-11-15

For example, one analysis finds that, under a worst case scenario, using ammonia as a fuel could have a greenhouse gas footprint as bad as burning an equivalent amount of coal. "We can't just be hoping these things work," says Amilcare Porporato, an environmental engineer at Princeton University and a co-author of the study, which was published last week in the Proceedings of the National Academy of Sciences. "We need to do due diligence."

These potential side effects are too often overlooked, says Paul Wolfram, a researcher at the Joint Global Change Research Institute. "The focus is almost solely on [carbon dioxide] emissions," he says.

Today, hydrogen and ammonia mainly come from energy-intensive, polluting processes. But they can also be made cleanly, with renewable electricity, resulting in a green fuel. Green hydrogen got a boost last month, when the U.S. Department of Energy announced $7 billion in funding to support several hubs to make it. Ammonia has an additional advantage: Unlike hydrogen, it can be liquefied at mild pressures and transported relatively easily

As climate-friendly fuels, hydrogen (H2) and ammonia (NH3) are enticing. Because they lack carbon, they can be burned to produce nothing but environmentally benign water and nitrogen (N2).

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When ammonia leaks or isn't burned completely, however, the nitrogen it contains can give rise to reactive nitrogen species. These compounds include nitrous oxide (N2O), a greenhouse gas about 273 times more potent than carbon dioxide, and other nitrogen oxides, collectively called NOx, which are notorious air pollutants. For instance, NO2 is a key ingredient in smog and acid rain and leads to the formation of particles that can cause asthma.

Porporato and his colleagues modeled best and worst case scenarios in a society that could be producing some 1600 million tons of ammonia per year by 2060–70. (Currently, the annual ammonia market is about 180 million tons per year, and most is used for fertilizer.) They looked at scenarios in which between 0.5% and 5% of the nitrogen in ammonia was lost as reactive nitrogen compounds instead of being converted back into harmless atmospheric nitrogen. They found that emission rates of nitrous oxide in particular controlled whether ammonia would help control global warming or harm the climate as much as burning coal.

Hideaki Kobayashi, a combustion engineer developing ammonia turbines at Tohoku University, says the group's projections are too pessimistic. His turbines, he says, burn ammonia efficiently and produce little to no nitrous oxide, while catalytic converters in the exhaust systems get rid of any nitrogen oxides. And he says regulations will help limit emissions in Japan and elsewhere.

But Wolfram worries about the potential for rogue emissions in the marine shipping industry, which is now rolling out ammonia-powered ships. In a 2022 study of the potential impacts, he and his colleagues found that switching the entire maritime shipping industry to ammonia would take about four times as much of the chemical as the market currently produces. If just 0.4% of the nitrogen in this fuel were converted to nitrous oxide, they found it would completely zero out the benefits of switching from carbon-based fuels. The shipping industry is regulated by the International Marine Organization, but it may be hard to spot leaks from individual ships, Wolfram says. "To me it seems hard to monitor and control all these emissions."

Hydrogen also comes with problems. Leaks from pipelines and other infrastructure could indirectly lead to rising levels of methane, a strong greenhouse gas emitted by natural sources and fossil fuel production. That's because hydrogen reacts with and depletes hydroxyl radicals, chemical species in the atmosphere that play a key role in breaking down methane.

A 2022 analysis of green hydrogen found that if leak rates are as high as 10%, its climate impact would be about half that of an equivalent amount of fossil fuels—still an improvement, but not quite living up to hydrogen's promise. Keeping the leakage to just 1% or so could preserve the climate benefits, the study found.

To know what to expect, researchers need more data about real-world leak rates, says Ilissa Ocko, a climate scientist at the Environmental Defense Fund (EDF) who led the 2022 study. Next year, EDF will launch a monitoring campaign in Europe and North America to provide what Ocko says are the first measurements of leak rates in the field.

The ammonia and hydrogen economies are in their infancy but could soon grow up, she adds. "We need to make sure we address these issues before it becomes a problem."

Science, 15 November 2023

https://science.org

Molecular Treatment Helps Mice Regain Brain Function After Stroke

2023-12-04

Researchers have succeeded in restoring lost brain function in mouse models of stroke using small molecules that in the future could potentially be developed into a stroke recovery therapy. "Communication between nerve cells in large parts of the brain changes after a stroke and we show that it can be partially restored with the treatment", says Tadeusz Wieloch, senior professor of neurobiology at Lund University in Sweden.

"Concomitantly, the rodents regain lost somatosensory functions, something that around 60 per cent of all stroke patients experience today. The most remarkable result is that the treatment began several days after a stroke," Wieloch continues.

In an ischemic stroke, lack of blood flow to the brain causes damage, which rapidly leads to nerve cell loss that affects large parts of the the vast network of nerve cells in the brain. This may lead to loss of function such as paralysis, sensorimotor impairment and vision and speech difficulties, but also to pain and depression. There are currently no approved drugs that improve or restore the functions after a stroke, apart from clot-dissolving treatment in the acute phase (within 4.5 hours of the stroke). Some spontaneous improvements occur, but many stroke patients suffer

A class of small molecules has been shown to help mice regain brain function after a stroke.

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chronic loss of function. For example, about 60 per cent of stroke sufferers, experience lost somatosensori functions such as touch and position sense.

An international study published recently in the journal Brain and led by a research team from Lund University in collaboration with University of Rome La Sapeinza and Washington University at St. Louis, shows promising results in mice and rats that were treated with a class of substances that inhibit the metabotropic glutamate receptor (mGluR5), a receptor that regulates communication in the brain's nerve cell network.

Technology Networks, 04 December 2023

https://technologynetworks.com

Durable plastic pollution easily, cleanly degrades with new catalyst

2023-11-30

The main issue behind Nylon-6, the plastic inside these nets, carpet and clothing, is that it's too strong and durable to break down on its own. So, once it's in the environment, it lingers for thousands of years, littering waterways, breaking corals and strangling birds and sea life.

Now, Northwestern University chemists have developed a new catalyst that quickly, cleanly and completely breaks down Nylon-6 in a matter of minutes—without generating harmful byproducts. Even better: The process does not require toxic solvents, expensive materials or extreme conditions, making it practical for everyday applications.

Not only could this new catalyst play an important role in environmental remediation, it also could perform the first step in upcycling Nylon-6 wastes into higher-value products.

The research was published on Thursday (Nov. 30) in the journal Chem.

"The whole world is aware of the plastic problem," said Northwestern's Tobin Marks, the study's senior author. "Plastic is a part of our society; we use so much of it. But the problem is: What do we do when we're finished with it? Ideally, we wouldn't burn it or put it into landfills. We would recycle it. We're developing catalysts that deconstruct these polymers, returning them to their original form, so they can be reused."

Marks is the Charles E. and Emma H. Morrison Professor of Chemistry and Vladimir N. Ipatieff Professor of Catalytic Chemistry at Northwestern's

Many people are familiar with the haunting images of wildlife—including sea turtles, dolphins and seals—tangled in abandoned fishing nets.

Weinberg College of Arts and Sciences and a professor of materials science and engineering at Northwestern's McCormick School of Engineering.

He also is a faculty affiliate at the Paula M. Trienens Institute for Sustainability and Energy. Northwestern co-authors include Linda J. Broadbelt, the Sarah Rebecca Roland Professor of Chemical and Biological Engineering and senior associate dean of McCormick, and Yosi Kratish, a research assistant professor in Marks' group.

A deadly difficulty

From clothing to carpet to seat belts, Nylon-6 is found in a variety of materials that most people use every day. But, when people are done with these materials, they end up in landfills or worse: loose in the environment, including the ocean. According to the World Wildlife Federation, up to 1 million pounds of fishing gear is abandoned in the ocean each year, with fishing nets composed of Nylon-6 making up at least 46% of the Great Pacific Garbage Patch.

"Fishing nets lose quality after a couple years of use," said Liwei Ye, the paper's lead first author who is a postdoctoral fellow in Marks' laboratory. "They become so water-logged that it's difficult to pull them out of the ocean. And they are so cheap to replace that people just leave them in the water and buy new ones."

"There is a lot of garbage in the ocean," Marks added. "Cardboard and food waste biodegrades. Metals sink to the bottom. Then we are left with the plastics."

The greenest solvent is no solvent

Current methods to dispose of Nylon-6 are limited to simply burying it in landfills. When Nylon-6 is burned, it emits toxic pollutants such as nitrogen oxides, which are linked to various health complications including premature death, or carbon dioxide, an infamously potent greenhouse gas.

Although other laboratories have explored catalysts to degrade Nylon-6, those catalysts require extreme conditions (such as temperatures as high as 350° Celsius), high-pressure steam (which is energetically expensive and inefficient) and/or toxic solvents that only contribute to more pollution.

"You can dissolve plastics in acid, but then you are left with dirty water," Marks said. "What do you do with that? The goal is always to use a green solvent. And what type of solvent is greener than no solvent at all?"

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Recovering building blocks for upcycling

To bypass these issues, the researchers looked to a novel catalyst already developed in Marks' laboratory. The catalyst harnesses yttrium (an inexpensive Earth-abundant metal) and lanthanide ions. When the team heated Nylon-6 samples to melting temperatures and applied the catalyst without a solvent, the plastic fell apart—reverting to its original building blocks without leaving byproducts behind.

"You can think of a polymer like a necklace or a string of pearls," Marks explained. "In this analogy, each pearl is a monomer. These monomers are the building blocks. We devised a way to break down the necklace but recover those pearls."

In experiments, Marks and his team were able to recover 99% of plastics' original monomers. In principle, those monomers then could be upcycled into higher-value products, which are currently in high demand for their strength and durability.

"Recycled nylon is actually worth more money than regular nylon," Marks said. "Many high-end fashion brands use recycled nylon in clothes."

Efficiently targeting Nylon-6

In addition to recovering a high yield of monomers, the catalyst is highly selective—acting only on the Nylon-6 polymers without disrupting surrounding materials. This means industry could apply the catalyst to large volumes of unsorted waste and selectively target Nylon-6.

"If you don't have a catalyst that's selective, then how do you separate the nylon from the rest of waste?" Marks said. "You would need to hire humans to sort through all the waste to remove the nylon. That's enormously expensive and inefficient. But if the catalyst only degrades the nylon and leaves everything else behind, that's incredibly efficient."

Recycling these monomers also avoids the need to produce more plastics from scratch.

"These monomers are produced from crude oil, so they have a huge carbon footprint," Ye said. "That's just not sustainable."

What's next?

After filing a patent for the new process, Marks and his team have already received interest from potential industrial partners. They hope others can use their catalysts on a large scale to help solve the global plastic problem.

"Our research represents a significant step forward in the field of polymer recycling and sustainable materials management," Ye said. "The innovative approach addresses a critical gap in current recycling technologies, offering a practical and efficient solution for the nylon waste problem. We believe it has implications for reducing the environmental footprint of plastics and contributing to a circular economy."

Phys Org, 30 November 2023

https://phys.org

Researchers decode aqueous amino acid's potential for direct air capture of CO2

2023-12-04

The recently published research focused on the foundational steps of carbon dioxide sequestration using aqueous glycine, an amino acid known for its absorbent qualities.

By combining a series of advanced computational methods, the scientists probed less-explored dynamic phenomena in liquid solutions related to the rate at which carbon dioxide can be captured.

"Chemical reactions in water are complicated, especially when the motion of water molecules plays a big role," said Santanu Roy, who designed the computational investigation with colleague Vyacheslav Bryantsev.

"Water molecules and chemicals engage in something similar to a coupled dance that can marginally or significantly slow the reaction. Understanding these dynamic interactions, known as nonequilibrium solvent effects, is essential to getting the full picture of how reactions work and how fast they happen."

The researchers discovered that when examining the rate at which carbon dioxide is absorbed, focusing solely on the free energy barrier -- the energy threshold that must be overcome for a system to transition from one state to another -- is an oversimplification that does not provide the full picture.

This incomplete approach can lead to an inaccurate understanding of reaction kinetics, the factors that influence the speed at which a reaction occurs.

Scientists at the Department of Energy's Oak Ridge National Laboratory have made a significant stride toward understanding a viable process for direct air capture, or DAC, of carbon dioxide from the atmosphere.

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"We employed a more complete approach that considers the influence of water on the motion along the reaction path, and the outcome was intriguing," Bryantsev said.

"The initial step, where glycine interacts with carbon dioxide, is nearly 800 times slower compared with the next step, where a proton is released to ultimately form a mixture of product state for holding the absorbed carbon dioxide. Strikingly, the free energy barrier remains constant for both steps, and so this different perspective truly sets the speed of these two critical stages apart and offers a pathway to boost the efficiency of carbon dioxide absorption and separation."

The extensive ab initio molecular dynamics simulations used in this study were still limited by their short time and length scales and high computational costs in representing the chemical reactions.

"For future projects, we intend to combine the emerging machine-learning approach with highly accurate simulations and develop interatomic interaction potentials based on deep neural networks. This will allow us to perform molecular simulations with high accuracy at large scales with significantly reduced computational costs," said Xinyou Ma, who carried out the simulations.

Roy added: "While we have portrayed a molecular-level kinetics picture of carbon dioxide capture by aqueous amino acids, accessing large length and time scales through the use of the machine-learning approach will help us understand the effects of macroscopic factors such as temperature, pressure and viscosity on DAC and how these effects are related to the attained molecular picture."

Overall, the study's findings shed light on the intricate workings of DAC and emphasize the vital role of kinetics, thermodynamics and molecular interactions in removing carbon dioxide from the atmosphere by aqueous amino acids. As these mechanisms become more accurately understood, the prospect of deploying a large-scale DAC technology will become more feasible. Worldwide, several different DAC projects are in various stages of research, testing and development.

Science Daily, 04 December 2023

https://sciencedaily.com

Superglue alternative made from soya is strong but biodegradable

2023-09-13

A biodegradable glue derived from soya bean oil forms high-strength bonds that later dissolve, offering hope for more sustainable commercial products, packaging and sticky labels.

The new adhesive can hold most materials together just as well as standard epoxies, which are plastics based on fossil fuels and take thousands of years to biodegrade. Replacing current epoxies with the soya alternative could prevent tonnes of microplastics being added into the oceans and landfills every year and potentially even cut glue-related carbon emissions fivefold, says Jonathan Wilker at Purdue University in Indiana.

"All these products that are held together with adhesive – electronics and shoes and furniture and walls and cars and books, and these cardboard boxes in my office with shipping labels on them – most of them never get recycled, because you just can't get that stuff off," he says.

Wilker and his colleagues were inspired by previous research on the natural adhesives mussels use to bond to rocks. They discovered that they could add specific acids to soya bean oil to mimic the sticky chemical properties in the mussel adhesive.

The team tested its soya-based adhesive with metal, wood and synthetic surfaces, finding that it generally created bonds of equivalent strength compared with petroleum epoxies. The soya glue was even about 30 per cent stronger than superglue for holding together polished aluminium. While heating at 180°C provided the greatest strength, 5 minutes of heating with a commercial hairdryer made a strong enough bond for many industrial applications.

After one week underwater, the bonds still maintained up to 78 per cent of their original strength. By varying the temperature and duration of heating, the adhesive's strength and biodegradation timing can be tailored for different applications – such as glue that lasts a week for labels or years for telephones, says Wilker.

Petroleum epoxy manufacture generates about 5.8 tonnes of carbon dioxide for each tonne of product. While the calculations are complex and inexact, it is possible that net CO2 emissions would be negative for the new glue, since soya plants absorb carbon dioxide, says Wilker.

Most adhesives are made from fossil fuels and take thousands of years to biodegrade, but a new alternative derived from soya plants bonds metal, wood and synthetic surfaces just as strongly.

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Current manufacturing price estimates suggest that the soya glue would cost about 30 per cent more to manufacture than standard epoxy does – meaning it could still be reasonably affordable.

Even so, the soya adhesive might not be sufficient for glueing together automotive and aerospace structures, says Wilker. "If you're trying to make a plane or a car, you never want it to come apart."

New Scientist, 13 September 2023

https://newscientist.com

Human Cell "Biobots" Encourage Neuron Regrowth in Lab Dishes

2023-11-30

Made from human cells, researchers have created tiny biological robots – called Anthrobots – that can move across surfaces and even encourage regrowth in damaged regions in dishes of lab-grown neurons. The findings of the study, published in Advanced Science, could one day lead to the development of patient-derived therapeutic "biobots."

The rise of the Anthrobot

Similar multicellular biological robots – known as "Xenobots" – have previously been developed from embryonic cells of the African clawed frog, Xenopus laevis.

Researchers sculpted the embryonic cells into multicellular structures, observing that the resulting Xenobots could navigate passageways, collect material and record information – even replicating themselves for a few cycles and healing after injury.

These frogs are commonly studied in the laboratory, but it wasn't clear whether their ability to generate biobots stemmed from their amphibian embryo origins, or if it might be possible to generate similar bots from other species.

In the current study, the researchers sought to discover whether biobots could be created from human cells, creating biobots – termed "Anthrobots" – from human lung cells.

"We wanted to show that no, it's universal, and that we could study the software of life by letting normal adult human cells reboot their multicellularity to see what they would do," says Dr. Michael Levin,

The "Anthrobots" encouraged the regrowth of "wounds" created in plated human neurons in the lab.

distinguished professor at Tufts University and the senior author of the study, speaking to Technology Networks.

"Our main impetus for making these biobots was to try to find a new model in which we can explore the latent space around a normal genome – what else can cells do in terms of behavior, new morphologies and effects on other cells without editing the genetic material or micromanaging the construction process (i.e., exploiting self-assembly)," Levin continued.

Anthrobot characteristics

The Anthrobots were created from single cells taken from the surface of the trachea – or windpipe – without the need for genetic modification, and they survived for 45–60 days in the laboratory before naturally degrading.

They came in a variety of shapes – some spherical, some elliptical and with different coverages of cilia – and this affected their movement. Tiny hair-like cilia on the cells' exterior allow them to move around in different patterns.

Spherical bots with full cilia coverage tended to stay put and wiggle, whereas unevenly shaped ones with uneven cilia tended to move in longer paths that were either straight or slightly curved.

Additionally, experiments showed that the Anthrobots' abilities surpassed that of the Xenobots – they were able to pass over neurons grown on lab dishes, even aiding new neuronal cell growth after artificial "wounds" were created by scratching a gap in the plated cells.

Though the mechanisms underpinning this effect are not yet known, the researchers observed that areas of new growth were covered by a large formation of Anthrobots termed a "superbot."

Therapeutic potential

"One limitation is that we don't yet know how exactly they knit the neural wounds together (but we know it's not a passive process since we tried replacing them with other materials and it doesn't work)," explains Levin. "We don't know their ability to sense, their preferences and ability to learn from experience (if any) – we need to do a full behavioral characterization to understand what they already do and how to manipulate that for useful applications."

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If used for therapeutic purposes, Anthrobots could potentially be produced from a patient's own cells, the researchers say, reducing the risk of being attacked by the immune system. In this way, they could be designed to perform various functions such as healing tissues, delivering drugs or recognizing bacteria.

"In the long term, this is a kind of sandbox platform in which we can learn to crack the morphogenetic code: what are the environments and stimuli that unlock new capabilities in normal genetically unmodified cells? How do we learn to control the collective competencies of cells toward new forms and functions?" says Levin.

Technology Networks, 30 November 2023

https://technologynetworks.com

Stem cell breakthrough may mean better treatment for Parkinson's disease

2023-12-05

In Parkinson's disease (PD), dopaminergic neurons in the substantia nigra, the part of the midbrain that controls movement, progressively degenerate and die, leading to a reduction in dopamine. With less dopamine, the millions of nerve and muscle cells required for movement can't coordinate effectively, resulting in the tremors, rigidity and shuffling gait that are hallmarks of the disease. Currently, PD treatment is focused on symptom control, predominantly using medications to boost dopamine levels, which can produce problematic side effects.

Stem cell therapy has emerged as a promising treatment for the disease, using undifferentiated cells that develop into midbrain dopaminergic neurons to replace the damaged or lost ones, thereby improving motor deficits.

However, stem cell therapy's effectiveness depends on the purity of midbrain dopamine neurons derived from stem cells. Cell purity and identity are essential because, unlike drugs, cells can persist in the body for a lifetime. Current stem cell differentiation techniques can produce variable results in terms of purity, but now, researchers from the Danish Research Institute of Translational Neuroscience (DANDRITE) have used genetic engineering to guide stem cells to differentiate into the dopaminergic neurons required to treat PD.

Researchers have genetically engineered stem cells so that they differentiate into greater numbers of the specific dopamine-producing neurons needed for effective Parkinson's disease cell therapy.

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"Stem cells offer promising potential for treating Parkinson's disease by transforming into specific nerve cells," said Mark Denham, corresponding author of the study outlining the researchers' novel method. "However, the precision of this transformation process poses a significant challenge with current methods, resulting in low purity."

Addressing the overall low yield of midbrain dopaminergic neurons that can result from stem cell differentiation, the researchers focused on the gene regulatory networks that determine cell fate. By knocking out genes involved in early cell lineage specification, they engineered pluripotent stem cells with restricted differentiation potential, enhancing the likelihood they'd differentiate into midbrain dopaminergic neurons and not 'undesired' lineages.

The researchers named the engineered cells lineage-restricted undifferentiated stem cells or LR-USCs. Importantly, LR-USCs generated significantly more midbrain dopaminergic neurons than unedited cell lines. And, when they transplanted LR-USCs into PD model rats, the animals' motor behavior improved.

"Using our genetically engineered cells, we generate a higher purity of dopamine cells; for patients, this will reduce the recovery time and diminish the risk of relapse and medication use," Denham said. "My goal is to help patients stay off their medication, which requires purity. So, my next step is to transfer my method to clinical trials."

The researchers say their method has significant advantages for clinical applications, allowing for easy upscaling and reproducibility and reduced cell line variability. In addition, by deleting different sets of genes, LR-USCs can be designed to preferentially generate other neural populations or cell types, which could be used for cell transplantation therapy or drug discovery to treat a range of disorders.

New Atlas, 05 December 2023

https://newatlas.com

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Nanopore test could identify misfolded proteins in Alzheimer's and Parkinson's disease

2023-12-05

While the characterisation of harmful oligomers is crucial to developing more accurate diagnoses and breakthrough treatments for diseases that involve misfolded proteins, identifying them in complex mixtures has remained a challenge.

Nanopore sensors have been in the works for several decades and have great potential to detect a wide range of molecules rapidly. '[They] enable the detection and quantification of molecules by driving them through a nano-sized opening,' explains Ulrich Keyser at the University of Cambridge and one of the study's lead authors along with his colleague Michele Vendruscolo.

Broadly speaking, there are two types of nanopore: pore-like proteins embedded in membranes and solid-state ones, fabricated by creating nano-sized openings in a material.

'One of the major successes of biological nanopore sensing is the possibility to perform DNA sequencing, as commercialised by Oxford Nanopore Technologies,' explains Joshua Edel at Imperial College London, who was not involved in the project but has conducted similar research. 'There is an unmet need to develop platforms that can rapidly detect a large array of biomarkers directly from patient samples. This offers the possibility for performing longitudinal disease tracking or even early disease detection.'

This is where solid-state nanopores have an advantage. They allow for direct measurements by eliminating the need to separate a sample, and pore size can be tuned to suit the target analyte – even those that have been difficult to quantify in complex biological samples. In this work the team created 10–15nm wide nanopores in a polymer membrane using commercially available quartz capillaries.

'Oligomers are transient, conformationally heterogeneous, and present at very low concentrations,' explains co-author Robert Horne. 'There are thus very few methods sensitive enough for detecting them alongside cell components while effectively differentiating them from monomeric proteins and larger aggregates.'

In typical solid-state nanopore sensors, the nanoporous material is immersed in an electrolyte solution and electrodes are placed on either

A high throughput, single molecule test based on nanopores and DNA barcoding has been developed and it could help uncover aggregates of misfolded proteins implicated in Alzheimer's and Parkinson's disease.

side of the pores, creating an electric field across them. Biomolecules of interest are introduced into the electrolyte and the electric field drives them through the pores one at a time. 'As molecules move through, the liquid containing salt ions is displaced,' says Keyser. 'The drop in liquid volume correlates to an increase in resistance, and thus a drop in current.'

This change in current can be used to determine the weight, conformation and charge of molecules present in the sample. However, a challenge is the rapid speed at which molecules move through the pores, leading to variability in results and limited resolution.

'To solve this, we used customisable DNA nanostructures and bound proteins to them,' says Sarah Sandler, a PhD researcher in the Keyser group. 'Using the current signal, we observe a "barcode" created using DNA nanostructures. Next to this barcode, we have a small piece of DNA tagged with a chemical group that can bind only to the protein oligomers, creating an additional spike.'

The advantage is every oligomer can be clearly identified and aggregates from different screens can be mixed and tested simultaneously, enabling investigation in greater detail and at higher throughput than previously possible.

As a proof-of-concept, the DNA nanostructures were designed to bind to oligomers of α-synuclein – the protein implicated in Parkinson's. They also studied the rate of oligomer formation in the presence of several small molecule inhibitors of α-synuclein aggregation.

The team demonstrated comparable performance to micro free-flow electrophoresis, an existing single-molecule technique that allows full characterisation of oligomers under biological conditions. The advantage of the nanopore sensor is a greater potential for high throughput testing and scale up.

'The ability to characterise individual protein complexes, particularly those undergoing dynamic assembly, has been of high interest,' says Yujia Qing, an organic chemist at Oxford University, who was not involved in the study. 'This not only offers promise for future inhibitor screening but also presents the potential … for early diagnosis of Parkinson's disease.'

Chemistry World, 5 December 2023

https://chemistryworld.com

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200 New Kinds of CRISPR Systems Discovered

2023-11-24

By analyzing bacterial data, researchers have discovered thousands of rare new CRISPR systems that have a range of functions and could enable gene editing, diagnostics, and more.

Microbial sequence databases contain a wealth of information about enzymes and other molecules that could be adapted for biotechnology. But these databases have grown so large in recent years that they've become difficult to search efficiently for enzymes of interest.

Now, scientists at the Broad Institute of MIT and Harvard, the McGovern Institute for Brain Research at MIT, and the National Center for Biotechnology Information (NCBI) at the National Institutes of Health have developed a new search algorithm that has identified 188 kinds of new rare CRISPR systems in bacterial genomes, encompassing thousands of individual systems. The work appears today in Science.

The algorithm, which comes from the lab of CRISPR pioneer Feng Zhang, uses big-data clustering approaches to rapidly search massive amounts of genomic data. The team used their algorithm, called Fast Locality-Sensitive Hashing-based clustering (FLSHclust) to mine three major public databases that contain data from a wide range of unusual bacteria, including ones found in coal mines, breweries, Antarctic lakes, and dog saliva. The scientists found a surprising number and diversity of CRISPR systems, including ones that could make edits to DNA in human cells, others that can target RNA, and many with a variety of other functions.

A new algorithm has identified nearly 200 new kinds of rare CRISPR systems in bacterial genomes.

The new systems could potentially be harnessed to edit mammalian cells with fewer off-target effects than current Cas9 systems. They could also one day be used as diagnostics or serve as molecular records of activity inside cells.

The researchers say their search highlights an unprecedented level of diversity and flexibility of CRISPR and that there are likely many more rare systems yet to be discovered as databases continue to grow.

"Biodiversity is such a treasure trove, and as we continue to sequence more genomes and metagenomic samples, there is a growing need for better tools, like FLSHclust, to search that sequence space to find the molecular gems," said Zhang, a co-senior author on the study and a core institute member at the Broad.

Zhang is also an investigator at the McGovern Institute for Brain Research at MIT, the James and Patricia Poitras Professor of Neuroscience at MIT with joint appointments in the departments of Brain and Cognitive Sciences and Biological Engineering, and an investigator at the Howard Hughes Medical Institute. Eugene Koonin, a distinguished investigator at the NCBI, is co-senior author on the study as well.

Searching for CRISPR

CRISPR, which stands for Clustered Regularly Interspaced Short Palindromic Repeats, is a bacterial defense system that has been engineered into many tools for genome editing and diagnostics.

To mine databases of protein and nucleic acid sequences for novel CRISPR systems, the researchers developed an algorithm based on an approach borrowed from the big data community. This technique, called locality-sensitive hashing, clusters together objects that are similar but not exactly identical. Using this approach allowed the team to probe billions of protein and DNA sequences — from the NCBI, its Whole Genome Shotgun database, and the Joint Genome Institute — in weeks, whereas previous methods that look for identical objects would have taken months. They designed their algorithm to look for genes associated with CRISPR.

"This new algorithm allows us to parse through data in a time frame that's short enough that we can actually recover results and make biological hypotheses," said Soumya Kannan, who is a co-first author on the study. Kannan was a graduate student in Zhang's lab when the study began and is currently a postdoctoral researcher and Junior Fellow at Harvard University. Han Altae-Tran, a graduate student in Zhang's lab during the study and currently a postdoctoral researcher at the University of Washington, was the study's other co-first author.

"This is a testament to what you can do when you improve on the methods for exploration and use as much data as possible," said Altae-Tran. "It's really exciting to be able to improve the scale at which we search."

New systems

In their analysis, Altae-Tran, Kannan, and their colleagues noticed that the thousands of CRISPR systems they found fell into a few existing and many new categories. They studied several of the new systems in greater detail in the lab.

They found several new variants of known Type I CRISPR systems, which use a guide RNA that is 32 base pairs long rather than the 20-nucleotide

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guide of Cas9. Because of their longer guide RNAs, these Type I systems could potentially be used to develop more precise gene-editing technology that is less prone to off-target editing. Zhang's team showed that two of these systems could make short edits in the DNA of human cells. And because these Type I systems are similar in size to CRISPR-Cas9, they could likely be delivered to cells in animals or humans using the same gene-delivery technologies being used today for CRISPR.

One of the Type I systems also showed "collateral activity" — broad degradation of nucleic acids after the CRISPR protein binds its target. Scientists have used similar systems to make infectious disease diagnostics such as SHERLOCK, a tool capable of rapidly sensing a single molecule of DNA or RNA. Zhang's team thinks the new systems could be adapted for diagnostic technologies as well.

The researchers also uncovered new mechanisms of action for some Type IV CRISPR systems, and a Type VII system that precisely targets RNA, which could potentially be used in RNA editing. Other systems could potentially be used as recording tools — a molecular document of when a gene was expressed — or as sensors of specific activity in a living cell.

Mining data

The scientists say their algorithm could aid in the search for other biochemical systems. "This search algorithm could be used by anyone who wants to work with these large databases for studying how proteins evolve or discovering new genes," Altae-Tran said.

The researchers add that their findings illustrate not only how diverse CRISPR systems are, but also that most are rare and only found in unusual bacteria. "Some of these microbial systems were exclusively found in water from coal mines," Kannan said. "If someone hadn't been interested in that, we may never have seen those systems. Broadening our sampling diversity is really important to continue expanding the diversity of what we can discover."

Technology Networks, 24 November 2023

https://technologynetworks.com

Last year, BMW and Michigan startup Our Next Energy (ONE) announced a partnership to test the latter's Gemini battery system with the goal of increasing the BMW iX's all-electric range to 600 miles (966 km).

Split-chemistry battery boosts BMW iX all-electric range to 608 miles

2023-12-04

Prior to its 2022 BMW collaboration announcement, ONE had successfully used its Gemini battery to return 752 miles (1,210 km) of range in a Tesla Model S. With the iX, it moved to test the battery's efficacy in a larger SUV application. While the iX is billed as BMW's most aerodynamic SUV, its 0.25 drag coefficient is higher than the Model S' 0.208.

Although 752 miles was never in the cards for the iX, ONE has had its sights on 600 miles+ by using a battery it claims as the longest-range pack that can fit in 300 to 400 liters worth of vehicular space. More specifically, the iX Genesis battery has a 185-kWh capacity, takes up 411 liters of under-floor volume and weighs 1,565 lb (710 kg). ONE has officially confirmed that it was able to drive the Genesis-powered iX for 608.1 miles (979 km, WLTP) per charge on the WLTP test cycle.

The standard production iX, meanwhile, has a WLTP range of 257 miles (414 km) when equipped with the base 71-kWh battery pack or up to 392 miles (630 km) with the 105-kWh battery pack.

The Gemini pack is actually a two-in-one design. Roughly half of the skateboard-style chassis pack is dedicated to traditional lithium-iron-phosphate (LFP) cells power the electric drive and provide enough energy for daily trips of 150 miles (241 km) or less. For longer voyages, the second half of the pack houses more energy-dense anode-free (AF) cells that serve as range extenders, teaming with ONE's proprietary high-efficiency DC-to-DC converter for an additional 450 miles+ (724 km+). These AF cells more than double the LFP cells' 441 Wh/L energy density to just over 1,000-Wh/L.

"Electric vehicles will achieve mass adoption when they offer enough range that people will feel comfortable having an EV as their only vehicle," opined Mujeeb Ijaz, ONE's CEO & founder. "The Gemini battery has proven it can break down the biggest barrier to electrification."

The split-chemistry layout also virtually eliminates cobalt usage, slashes nickel usage by 75%, graphite by 60% and lithium by 20%, according to ONE.

ONE plans to continue refining the Gemini design toward commercialization. Specifically, it is working on increasing the efficiency of the DC-to-DC converter, developing enhanced control algorithms

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to optimize usage of the range-extender cells, and conducting further battery validation and cell development. It then intends to prepare an A-sample for a full production program.

New Atlas, 04 December 2023

https://newatlas.com

Researchers call for 'urgent' research into engineered stone alternatives

2023-12-05

This raises important questions about use of alternatives for the popular stone benchtops.

"Many countries worldwide have witnessed the re-emergence of silicosis, a historical occupational lung disease that should have been extinct," the researchers from Adelaide and Hobart write in a new paper in the journal Respirology.

"This is likely due to the emergence, and increasing popularity of, high-silica containing engineered stone products in the manufacturing industry."

"The outcomes of this study have important implications for future regulation of engineered stone products as they challenge the common view that reducing the crystalline silica alone will eliminate disease risk," the researchers conclude.

While high-silica engineered stone is slowly being phased out across the nation, alternatives with less silica are starting to emerge.

However, when researchers analysed fine particles of dust from 50 resin based engineered stones, three natural stones and two non-resin-based materials, they found that it was not just the silica that was causing issues.

In the cell-based study, immune cells called macrophages and lung cells were used to test for inflammation and cytotoxicity.

"From an ethical (and moral) perspective, we cannot expose humans to any hazards for research purposes. So really human lung cells grown in vitro are the next best thing," lead author Dr Chandnee Ramkissoon from the University of Adelaide, told Cosmos.

"They are a simple and powerful tool that enable us to explore with great accuracy how the lung would perform upon exposure to different hazards."

The deadly lung disease silicosis is becoming more prevalent in Australian workers – particularly in the 'engineered stone' industry.

The team found that while silica caused inflammation, cobalt and aluminium were also a problem.

"Metals like cobalt and aluminium are commonly present during artificial stone making. They can be present in raw materials or be added in for example as pigments used to give colour to stones. These metals have an established link to adverse respiratory health. In particular, excessive exposure to heavy metals like cobalt can cause respiratory disorders including bronchial asthma, chronic bronchitis and pulmonary fibrosis," said Ramkissoon.

"Our results showed that higher silica content was associated with more inflammation. However, their metallic components could also be hazardous to lung health."

The team stress that more urgent research needs to be done to find out which – if any – engineered stones are safe for the workers.

"We do need to tread carefully and allow future (urgent) research to evidence the safety," said Ramkissoon.

"Given the enormous harm that engineered stone has caused, and is continuing to cause, stone benchtop industry workers, it is crucial that we investigate the safety of these alternative products."

Last month Safe Work Australia released a 'regulation impact statement' recommending a prohibition on the use of all engineered stone, irrespective of crystalline silica content.

SWA said engineered stone workers were "significantly over-represented in silicosis cases".

Cosmos, 05 December 2023

https://cosmosmagazine.com

Antibiotic adjuvant designed to subvert bacterial defence mechanisms

2023-12-05

Antimicrobial resistance mechanisms in bacteria include reducing the permeability of their outer membrane and efflux pumps that extrude antibiotic drugs. The growing creep of drug-resistant infections means we are in urgent need of new antibiotics that bacteria have never encountered and lack a mechanism to resist. But drug development is slow and costly, compelling the scientific community to explore other ideas.

Researchers in India have shown that an amphiphilic molecule can enhance the bactericidal activity of obsolete antibiotics by helping such drugs accumulate within Gram-negative bacterial cells.

Administering an adjuvant molecule alongside an existing antibiotic is one such alternative. Some adjuvant molecules aid antibiotic delivery by permeabilising cell membranes and suppressing efflux pumps. But a notable drawback typically associated with these adjuvants is their lipophilicity. This characteristic enables antibiotics to pass through both bacterial and mammalian cell membranes, resulting in non-selective cell death.

Now, Jayanta Haldar and colleagues at Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) have designed and finely tuned the chemical make-up of a new molecular adjuvant to make it biocompatible with mammalian cells. Their adjuvant molecule features long hydrophobic chains to improve membrane permeability, accompanied by ethanol groups for amphiphilicity and to induce specific hydrogen bonding interactions with Gram-negative bacterial membranes.

Halder's team initially tested their molecular adjuvant in combination with the antibiotics rifampicin, fusidic acid, minocycline and chloramphenicol before deciding to focus on fusidic acid. In a cellular assay, a combination of fusidic acid and the molecular adjuvant was effective against biofilms produced by Acinetobacter baumannii, a type of bacteria that is responsible for many drug-resistant infections. Not only did the adjuvant enhance membrane penetration, it also inhibited efflux pumps, allowing fusidic acid to accumulate within the bacterial cells. The combination did not appear to be toxic to mammalian cells and had potent antibacterial activity in a mouse skin infection model.

However, Halder's lab did observe high lethality when administering the adjuvant intravenously to mice. The impact of this adjuvant on mammalian toxicity is therefore 'still something to be discussed and debated' says Nathaniel Martin, a professor of biological chemistry at Leiden University in the Netherlands. Another consideration for systemic application, says Martin, is the need for both molecules to locate the bacteria at the same time and place, requiring a match in their pKa profiles. Martin says that 'this is an aspect that will need to be addressed and optimised' in the future.

The research team at JNCASR acknowledges that devising a suitable delivery system for the adjuvant and antibiotic will be challenging. JNCASR team member Riya Mukherjee says they next need to perform in-depth mechanistic studies and pre-clinical efficacy tests. Mukherjee also

mentioned the need for monitoring resistance development, as 'although the combination therapy may be initially effective, there is always a risk of bacteria developing resistance over time'.

Despite the pitfalls, Martin says that 'the use of adjuvants to tailor the properties of existing antibiotics … can definitely be part of the solution' in the fight against Gram-negative superbugs.

Chemistry World, 05 December 2023

https://chemistryworld.com

Suite of Genes Influence Head Shape in Humans

2023-11-20

Researchers at the University of Pittsburgh and KU Leuven have discovered a suite of genes that influence head shape in humans. These findings, published this week in Nature Communications, help explain the diversity of human head shapes and may also offer important clues about the genetic basis of conditions that affect the skull, such as craniosynostosis.

By analyzing measurements of the cranial vault — the part of the skull that forms the rounded top of the head and protects the brain — the team identified 30 regions of the genome associated with different aspects of head shape, 29 of which have not been reported previously.

"Anthropologists have speculated and debated the genetics of cranial vault shape since the early 20th century," said co-senior author Seth Weinberg, Ph.D., professor of oral and craniofacial sciences in the Pitt School of Dental Medicine and co-director of the Center for Craniofacial and Dental Genetics. "We knew from certain rare human conditions and animal experiments that genes play an important role in vault size and shape, but very little was known about the genetic basis for typical features we see in the general population, such as what makes someone's head long and narrow versus short and wide. This study reveals some of the key genes driving variation in this part of the human body."

According to the researchers, one application of better understanding the factors that drive natural variation in human head shape is informing paleoanthropology studies, potentially shedding light on the early development of modern humans.

Weinberg and colleagues used magnetic resonance (MR) scans from more than 6,000 adolescents to extract 3D surfaces corresponding to the cranial vault. After dividing the 3D vault surfaces into incrementally smaller

Researchers have identified a suite of genes that influence head shape in humans, helping to explain head shape diversity.

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anatomical subparts and quantifying the shape of these subparts, they tested more than 10 million genetic variants for evidence of statistical association with measures of vault shape.

"Previous genetic studies of the cranial vault involved a small number of relatively simple measures," added Weinberg. "While such measures are often easy to obtain, they may fail to capture features that are biologically relevant. Our analysis used an innovative approach capable of describing 3D vault shape in much more comprehensive and nuanced ways. This approach increased our ability to find genetic associations."

An important discovery was that many of the strong associations are near genes that play key roles in the early formation of the head and face and regulation of bone development. For example, variants in and near the gene RUNX2, a major player in coordinating development of the skull, were associated with multiple aspects of vault shape.

While some genes, including RUNX2, had global effects involving the entire vault, others showed more localized effects that only impacted a specific portion of the vault, such as the central forehead.

When the researchers compared the 30 genomic regions associated with head shape across participants with European, African and Indigenous American ancestry, they found that the majority of genetic associations were shared across these different ancestral groups.

Although the study focused on healthy participants, the findings may reveal important clues about the biological basis of diseases involving the cranial vault, according to Weinberg.

One of these conditions is craniosynostosis, which occurs when the bones of the skull fuse too early while the brain is still growing rapidly. Without neurosurgery, craniosynostosis can cause permanent disfigurement, brain damage, blindness and even death. The team showed that variants near three genes associated with vault shape, BMP2, BBS9 and ZIC2, were also associated with craniosynostosis, suggesting that these genes could play a role in the development of the disease.

"This kind of study is possible due to the availability of publicly funded resources," said Weinberg. "The original study that generated these MR scans is focused on understanding brain development and behavior.

By creatively leveraging these resources, we have managed to advance discovery beyond that original scope."

Technology Networks, 20 November 2023

https://technologynetworks.com

Regular ketamine use found to restructure the brain's dopamine system

2023-12-04

Because of its illicit use as a party drug, ketamine has had a bad rap for a while. But its reputation has been rehabilitated somewhat, with recent studies suggesting that the drug is an effective treatment for people with depression, especially those with a treatment-resistant form of the condition.

Many of these studies have looked at how a single dose of ketamine can be beneficial for mental health. Now, using high-resolution whole-brain mapping on mice, new research by Columbia University has revealed how repeated ketamine use over extended periods affects the brain's dopamine system.

"This study gives us a deeper brain-wide perspective of how ketamine functions that we hope will contribute to improved uses of this highly promising drug in various clinical settings as well as help minimize its recreational abuse," said Raju Tomer, the study's corresponding author. "More broadly, the study demonstrates that the same type of neurons located in different brain regions can be affected differently by the same drug."

Dopamine functions as a neurotransmitter, a chemical released by neurons to send signals to other nerve cells, and acts on areas of the brain to give feelings of pleasure, satisfaction, and motivation. The brain contains four major dopamine pathways.

The researchers generated high-resolution whole-brain images of mice, which they used to study the dose-dependent effects of daily ketamine exposure – 30 mg/kg and 100 mg/kg for one, five, and 10 days – on the brain's entire dopamine system. They observed statistically significant neuronal changes only after 10 days of ketamine exposure for both 30 mg/kg and 100 mg/kg treatment groups.

In both groups, the researchers saw an overall dose-dependent decrease in dopamine neurons in midbrain regions related to mood regulation and,

Researchers have mapped the whole brain of mice, revealing how regular ketamine use produces divergent changes in specific areas of the brain responsible for producing the 'feel-good' neurotransmitter, dopamine.

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conversely, an overall increase within the hypothalamus, which regulates basic body functions like metabolism and homeostasis. Changes seen in the midbrain may explain why long-term abuse of ketamine can result in schizophrenia-like symptoms. Hypothalamic changes may help explain why ketamine has been found to be a promising treatment for eating disorders.

Tracking how ketamine affects dopamine networks across the brain, the researchers found that the drug reduced the density of dopamine axons, the impulse-conducting projections extending from a neuron, in brain areas responsible for hearing and sight, while increasing axons in the brain's cognitive centers. This may explain the drug's dissociative effects, the feeling of being 'detached' from surroundings and disconnected from the body.

Given the divergent brain alterations produced by ketamine, the study's findings suggest rethinking the way we currently use the drug and could have significant implications for the development of treatments for depression, schizophrenia and psychosis.

"Instead of bathing the entire brain in ketamine, as most therapies do, our whole-brain mapping data indicates that a safer approach would be to target specific parts of the brain with it, so as to minimize unintended effects on other dopamine regions of the brain," Tomer said.

The study was published in the journal Cell Reports.

New Atlas, 04 December 2023

https://newatlas.com

Novel mineral piezocatalysts offer innovative approaches for soil remediation

2023-12-05

A team of scientists has constructed a gradient F-doping hydroxyapatite core-shell structure (HAP@FAP) with the coupling effect of flexoelectricity and piezoelectricity for degradation of PAHs in soil that provide innovative approaches for soil remediation. Their work was published in the journal Industrial Chemistry & Materials.

The poor mass transfer process in conventional soil remediation methods remains a significant factor that hampers their further application. Recently, piezocatalysis has been developed as a new energy conversion technology. The mechanical vibration (ultrasound or stirring, etc.) can

Polycyclic aromatic hydrocarbons (PAHs) removal in the soil environment is of great significance for repairing the long-term damaged ecosystem.

induce lattice distortion of piezocatalysts and accelerate mass transfer in the soil system, leading to enhanced piezocatalytic degradation of PAHs in soil, which shows great potential in soil remediation.

Hydroxyapatite (Ca10(PO4)6(OH)2, HAP), as natural mineral piezocatalysts, exhibit unique advantages of environmental friendliness in the field of piezocatalytic soil remediation. However, the biggest challenge is the weak piezoelectric coefficient (1–16 pm V-1) of HAP, leading to low catalytic activity.

"How to construct HAP-based mineral piezocatalysts with high piezocatalytic activity for soil remediation is the direction of our team's efforts," explains Jianmei Lu, a professor at the Soochow University.

The researchers successfully fabricated a gradient F-doping HAP@FAP core-shell structure via a simple ion exchange method, which induced the coupling effect of piezoelectricity and flexoelectricity by built-in strain gradient for enhanced piezocatalytic activity.

The oxidative degradation of phenanthrene (PHE) in soil (200 mg kg-1) was carried out to evaluate the piezocatalytic activities of catalysts. HAP@FAP exhibited the optimized piezocatalytic activity that 79% PHE can be degraded under ultrasonic vibration for 120 min. This is significantly superior to pristine HAP and F-HAP with a solid solutions structure. In addition, the effects of catalyst dosage, water-to-soil ratio, and ultrasonic power on degradation performance were investigated.

The research team also proposed the possible mechanism of PHE degradation caused by piezoelectric polarization. The lattice strain gradient generated in the gradient F-doping core-shell direction induced flexoelectricity enhanced piezocatalytic activity.

Under continuous ultrasonic vibration, the polarized electric field in HAP@FAP drove charge carriers to the surface, generating reactive oxygen species for oxidative degradation of PHE ultimately into CO2 and H2O, achieving the goal of harmless treatment of soil pollutants.

Looking ahead, the research team hopes that their work might provide insights for the modification of piezoelectric catalysts for the remediation of organics-contaminated soils from industrial land. "We next plan to scale up to achieve the ultimate goal of industrial application. Our developed catalyst may be potentially applied in various persistent organic pollutants

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contaminated industrial land, such as polychlorinated biphenyls and naphthalene," said Lu.

Phys Org, 05 December 2023

https://phys.org

Researchers decode aqueous amino acid's potential for direct air capture of CO2

2023-12-03

The recently published research focused on the foundational steps of carbon dioxide sequestration using aqueous glycine, an amino acid known for its absorbent qualities.

By combining a series of advanced computational methods, the scientists probed less-explored dynamic phenomena in liquid solutions related to the rate at which carbon dioxide can be captured.

"Chemical reactions in water are complicated, especially when the motion of water molecules plays a big role," said Santanu Roy, who designed the computational investigation with colleague Vyacheslav Bryantsev.

"Water molecules and chemicals engage in something similar to a coupled dance that can marginally or significantly slow the reaction. Understanding these dynamic interactions, known as nonequilibrium solvent effects, is essential to getting the full picture of how reactions work and how fast they happen."

The researchers discovered that when examining the rate at which carbon dioxide is absorbed, focusing solely on the free energy barrier -- the energy threshold that must be overcome for a system to transition from one state to another -- is an oversimplification that does not provide the full picture.

This incomplete approach can lead to an inaccurate understanding of reaction kinetics, the factors that influence the speed at which a reaction occurs.

"We employed a more complete approach that considers the influence of water on the motion along the reaction path, and the outcome was intriguing," Bryantsev said.

"The initial step, where glycine interacts with carbon dioxide, is nearly 800 times slower compared with the next step, where a proton is released

Scientists at the Department of Energy's Oak Ridge National Laboratory have made a significant stride toward understanding a viable process for direct air capture, or DAC, of carbon dioxide from the atmosphere.

to ultimately form a mixture of product state for holding the absorbed carbon dioxide. Strikingly, the free energy barrier remains constant for both steps, and so this different perspective truly sets the speed of these two critical stages apart and offers a pathway to boost the efficiency of carbon dioxide absorption and separation."

The extensive ab initio molecular dynamics simulations used in this study were still limited by their short time and length scales and high computational costs in representing the chemical reactions.

"For future projects, we intend to combine the emerging machine-learning approach with highly accurate simulations and develop interatomic interaction potentials based on deep neural networks. This will allow us to perform molecular simulations with high accuracy at large scales with significantly reduced computational costs," said Xinyou Ma, who carried out the simulations.

Roy added: "While we have portrayed a molecular-level kinetics picture of carbon dioxide capture by aqueous amino acids, accessing large length and time scales through the use of the machine-learning approach will help us understand the effects of macroscopic factors such as temperature, pressure and viscosity on DAC and how these effects are related to the attained molecular picture."

Overall, the study's findings shed light on the intricate workings of DAC and emphasize the vital role of kinetics, thermodynamics and molecular interactions in removing carbon dioxide from the atmosphere by aqueous amino acids. As these mechanisms become more accurately understood, the prospect of deploying a large-scale DAC technology will become more feasible. Worldwide, several different DAC projects are in various stages of research, testing and development.

Science Daily, 04 December 2023

https://sciencedaily.com

Polyoxometalates show promise as drug transporters into the cell

2023-12-05

The therapeutic effectiveness of a drug depends on whether it reaches the target cells in the body and causes no or minimal side effects. A particular challenge for many potential drugs—especially for water-soluble bioactive molecules—is the passage through biological membranes in order to

A research team from the University of Vienna, in collaboration with the Constructor University in Bremen, showed that polyoxometalates (POMs) can transport biologically relevant cargo through biological membranes.

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subsequently achieve the specific targets of the therapeutic agent in the cells themselves.

The fact that a class of substances such as POMs, in addition to their already known potential in combating tumors, bacteria and viruses, can also act as "drug transporters" is a new discovery—and offers a promising solution to this long-standing challenge of overcoming membranes.

Successful passage

Polyoxometalates are a special chemical group of substances: They consist of oxygen-containing anions that contain several metal ions. These POMs are known for their extraordinary chemical property of super-chaotropy—the inherent tendency of large charge-delocalized anions to interact with hydrophobic matter.

Annette Rompel from the Institute of Biophysical Chemistry at the Faculty of Chemistry explains. "In our experiments, we were able to show both on model membranes and on living cells that certain mixed-metal POMs can be effective transporters for various active ingredients. POMs have a sufficient stability and can transport impermeable, hydrophilic and cationic peptides (proteins) through the membranes."

This overcoming of the membrane hurdle is critical to improving treatment precision and efficiency through improved cellular uptake—resulting in fewer side effects and better outcomes for patients.

Promising prospects

Nadiia Gumerova, a lead author of the study and senior inorganic scientist at the Institute for Biophysical Chemistry at the University of Vienna, is convinced of the possibilities that POMs offer as transport molecules. "POMs are a promising class of substances in medicine due to their enormous structural diversity. With our further investigations, we will be able to break new ground in drug delivery and open up new horizons in the pharmaceutical industry."

This new technology is already causing a stir in the scientific community—and the research team at the University of Vienna will continue to make every effort to push the boundaries of what is possible in drug research.

Phys Org, 05 December 2023

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