CHEMWATCH

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ASIA PACIFIC

New fungicide to protect potatoes, tomatoes, and onions

2022-04-14

A new fungicide to combat late blight in tomatoes and potato crops, and downy mildew in onions, has been approved for use in Aotearoa New Zealand, subject to conditions.

Xivana contains the active ingredient fluoxapiprolin, which is new to New Zealand. Alongside the European Union and Australia, New Zealand's Environmental Protection Authority (EPA) is among the first regulators worldwide to consider an approval for this substance.

The applicant, Bayer New Zealand Ltd, wants to import Xivana as a concentrate to be applied using ground-based or aerial methods. Bayer says the fungicide would always be manufactured overseas and arrive in New Zealand as a finished, packaged product ready for sale to professional users.

"Bayer says late blight is the most economically destructive disease of potatoes and outdoor tomato crops in this country. As well, Onions New Zealand told us new options for controlling downy mildew are desperately needed," says Dr Chris Hill, General Manager of the EPA's hazardous substances group.

The EPA considers that the new active ingredient, fluoxapiprolin, represents a significant benefit, as it could provide an additional tool for growers that is less hazardous than most comparable fungicides currently available on the market.

"In granting approval for Xivana, strict rules have been set for its use. These include a maximum of three uses a year per crop, at a restricted amount. Use of Xivana is also restricted to professional users in commercial settings," says Dr Hill.

The EPA is responsible for regulating chemicals and other dangerous goods and substances under the Hazardous Substances and New Organisms Act.

"This means we make decisions on whether to approve new hazardous substances. We put rules (called controls) in place to manage the risks of

hazardous substances and to safeguard people and the environment," says Dr Hill.

Read More

EPA NZ, 14-04-22

https://www.epa.govt.nz/news-and-alerts/latest-news/new-fungicide-to-protect-potatoes-tomatoes-and-onions/

Covid lockdown prompts China to delay deadline for data submission on cosmetics

2022-05-05

China has extended the deadline to submit certain data under its cosmetics regulation from 1 May until 31 December. The decision comes as several Chinese cities, including Shanghai, experience lockdowns or restrictions due to the Covid-19 pandemic.

On 27 April, the National Medical Products Administration (NMPA) published a notice outlining the new date for cosmetics registrants or filers to supply certain data under the country's overarching cosmetic regulation – the Cosmetics Supervision and Administration Regulation (CSAR).

This includes:

- product classification codes for cosmetics that have been approved before 1 May 2021; and
- product efficacy summaries for cosmetics approved between 1 May and 31 December 2021.

Industry is likely to welcome the extension for efficacy reports, because companies were having to choose between dropping these claims or delaying market entry to remain compliant, industry experts told Chemical Watch in January.

Since 1 January, businesses have been required to substantiate statements made on labels regarding a product's functioning, such as whitening, when submitting registrations or filings for new products under the CSAR, which is both time consuming and resource intensive.

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Chemical Watch, 05-05-22

https://chemicalwatch.com/475832/covid-lockdown-prompts-china-to-delay-deadline-for-data-submission-on-cosmetics

Bumpy start for South Korea's mandatory registration of nanomaterials

2022-05-06

Systems are still not in place for companies to comply

Companies in South Korea are finding it difficult to meet K-REACH registration requirements for nanomaterials, four months after the government introduced them.

This is because there is still no system in place to identify or register the substances.

The Ministry of Environment (MoE) published amendments to the Enforcement Regulations on the Registration and Evaluation of Chemicals making this mandatory from 1 January, after announcing plans to do so in November 2019.

Read More

Chemical Watch, 6-05-22

https://chemicalwatch.com/477028/bumpy-start-for-south-koreas-mandatory-registration-of-nanomaterials#utm_campaign=477336&utm_medium=email&utm_source=alert

AMERICA

PFAS in Food Packaging: Get Ready for New Regulations

2022-04-29

The federal government and several states are in the process of regulating PFAS chemicals in food packaging, and there is consumer litigation as well, write Bryan Cave partner Thomas Lee, associate Elyse Voyen, and attorney John Kindschuh. They discuss the issue and how businesses should prepare.

Have you ever wondered why your French fry box doesn't disintegrate, or your burger wrapper doesn't turn into a soggy mess?

The answer is a family of several thousand chemicals called per- and polyfluoroalkyl substances (PFAS). Certain PFAS compounds are incredibly effective at repelling water and oils (think fat and grease) and have been used in a wide range of consumer products including food packaging.

However, based on concerns about the impacts that certain PFAS compounds can have on human health and the environment, both the federal government and states have begun regulating the presence of these compounds in food packaging. For businesses that manufacture or use food packaging, it is important to understand the current regulatory environment.

Proposed Federal and State Legislation

The bi-partisan Keep Food Containers Safe from PFAS Act of 2021 was introduced in both the House and Senate in November 2021, and has been referred to committees in both chambers.

The relatively short bill would amend Section 301 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 331) to prohibit the "introduction or delivery for introduction into interstate commerce of food packaging containing intentionally added PFAS."

In the bill, PFAS is broadly defined to include all PFAS compounds with a fully fluorinated carbon atom, and not just the PFAS compounds that have been associated with human health effects and environmental effects. If enacted, this bill would essentially prohibit the use of PFAS in any new food packaging. The bill has not made it out of committee in either house, so it is unclear when, if at all, it will become law.

Additionally, the Food and Drug Administration issued a letter on Aug. 5, 2021, to manufacturers and distributors of fluorinated polyethylene food contact articles "as a reminder that only certain fluorinated polyethylene containers are authorized for food contact use." These containers—also referred to as high-density polyethylene (HDPE) containers—have been identified by the Environmental Protection Agency as a source of PFAS contamination in certain pesticides and are reportedly used during food product manufacturing.

As a result, there may be increased federal regulation of the packaging and containers used during food manufacturing, as well as consumer food packaging.

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Bloomberg Law, 29-04-22

https://news.bloomberglaw.com/health-law-and-business/pfas-in-food-packaging-get-ready-for-new-regulations

Pass the PFAS: Wisconsin communities grapple with 'forever chemicals' as state, federal officials stall regulation standards

2022-05-04

Lee Donahue had been a town supervisor for the town of Campbell located on French Island for all of six months when news came to her that the town's drinking water and groundwater had PFAS in it – forcing her to quickly get up to speed on the dangerous class of chemicals and what contamination meant for the island she'd called home for nearly 15 years.

PFAS, or Per- and polyfluoroalkyl substances, are a large class of chemical compounds, some of which have been linked to adverse health effects including decreased fertility, cancers, developmental delays in children, high cholesterol and more. Sometimes called "forever chemicals," PFAS are found everywhere — from non-stick pans and fast food wrappers to dental floss and firefighting foams.

Though PFAS were first created in the 1930s, the extent to which these chemicals impact human and ecological health is still being researched.

For the Wisconsin residents of Campbell, the news of these unknown substances appearing in the water bodies surrounding the island they live on was devastating. Not only is water crucial to everyday tasks and life, Lee said residents have to think twice before swimming, fishing and gardening — activities integral to Wisconsin culture

Despite a growing body of research that indicates exposure to these chemicals can be harmful to the human body, the Environmental Protection Agency has not created official standards for state regulators to determine how much PFAS can safely be in drinking and groundwater — though the EPA has said they are in the process of creating them.

Read More

The Badger Herald, 4-05-22

https://badgerherald.com/features/2022/05/04/pass-the-pfas-wisconsin-communities-grapple-with-forever-chemicals-as-state-federal-officials-stall-regulation-standards/

US EPA seeks data on asbestos imports and uses

2022-05-06

The US Environmental Protection Agency wants to know how much asbestos, including asbestos in mixtures and products, was imported or processed in the US over the last 4 years. It also wants information on how asbestos was used and on worker exposure.

Asbestos manufacturers, processors, and importers would need to report such information under a proposed rule the EPA announced May 5.

"Strong data and the best available science are the foundation of our work to protect communities from hazardous chemicals like asbestos," Michal Freedhoff, head of the EPA's chemical safety office, says in a statement. "Getting a more comprehensive and complete set of data on how and where this chemical is used is part of EPA's broader effort to evaluate the health risks from asbestos and, when needed, put protections in place."

The EPA committed to collecting the data as part of a legal settlement with the Asbestos Disease Awareness Organization (ADAO) and other public health and environmental groups.

"The lack of reporting obligations by the asbestos industry has been a gaping hole in EPA's efforts to protect Americans from exposure to this lethal carcinogen," Linda Reinstein, president and cofounder of ADAO, says in a statement.

Read More

Chemical & Engineering News, 6-05-22

https://cen.acs.org/policy/chemical-regulation/US-EPA-seeks-data-asbestos/100/web/2022/05

Proposed rule would require one-time reporting of exposure information

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PFAS class action lawsuits expected to keep increasing in US

2022-05-04

A recent rise in US class action lawsuits on PFAS-containing goods is only the start of a wave of litigation, with similar cases likely to emerge across sectors wherever PFASs are detected, several attorneys have predicted.

Any item with per- and polyfluoroalkyl substances that a company advertises as non-toxic or environmentally preferable could be subject to a class action based on consumer deception claims, the legal experts told Chemical Watch.

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Chemical Watch, 4-05-22

https://chemicalwatch.com/474765/pfas-class-action-lawsuits-expected-to-keep-increasing-in-us

EUROPE

European Parliament votes in favour of lowering POPs in waste

2022-05-05

The European Parliament has voted in favour of lower thresholds for certain persistent organic pollutants (POPs) in waste than those proposed by the European Commission under the EU's POPs Regulation.

Parliament voted 506 in favour – with 68 against and 49 abstentions – of threshold levels of:

- 200 milligrams per kilogram (mg/kg) for polybrominated diphenyl ethers (PBDEs); and
- mg/kg for PFOA and its salts and 20 mg/kg for PFOA-related compounds.

The Commission's proposal, published last November, set thresholds of:

- 500 mg/kg threshold for PBDEs that would be lowered to 200mg/kg five years later. The current limit is 1,000 mg/kg; and
- 1mg/kg for PFOA, 40mg/kg 0.1 mg/kg for PFOA and its salts, and 20 mg/kg for PFOA-related compounds.

Brominated flame retardants and PFOA under consideration

The Parliament said in a statement that this would better align the POPs Regulation with the EU's Green Deal goals, "especially the ambition for a toxic-free environment and a truly circular economy".

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Chemical Watch, 5-05-22

https://chemicalwatch.com/477026/european-parliament-votes-in-favour-of-lowering-pops-in-waste

European Commission drops cobalt restriction in favour of binding OELs

2022-05-05

The European Commission will stop the REACH restriction procedure for cobalt salts and focus on setting occupational exposure limits (OELs) for them instead, member state authorities were told at a meeting last week.

The move follows a long debate over the best risk management option (RMO) for the compounds, which has become representative of the messy interface between REACH and occupational safety and health (Osh) legislation.

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Chemical Watch, 5-05-22

https://chemicalwatch.com/476891/european-commission-drops-cobalt-restriction-in-favour-of-binding-oels

France plans to ban mineral oil in packaging and printing

2022-05-04

On January 3, 2022, as part of the implementation of the French AGEC law, the Ministry of Ecological Transition launched a public call for the draft Decree "Prohibition of the use of mineral oils in packaging and printed matter" .

The draft proposes specific restrictions on mineral oils.

The comment period closed on January 25, 2022. The draft proposes specific restrictions on mineral oils.

Prohibited mineral oils include:

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(*) Mineral oil aromatic hydrocarbons MOAH containing 1 to 7 aromatic rings

(*) Mineral oil saturated hydrocarbon MOSH containing 16 to 35 carbon atoms

Concentration in ink:

(*) MOAH (containing 1 to 7 aromatic rings): ≤0.1%, since January 1, 2025, MOAH (containing 3 to 7 aromatic rings) ≤1 ppb

(*) MOSH (C16~C35): ≤1%, after January 1, 2025, it will be reduced to ≤0.1%

Transition period:

(*) For packaging and printed matter manufactured or imported before 1/1/2023, a period of not more than 12 months will be given to dispose of the stock.

(*) In response to the enhanced requirements after 1/1/2025, packaging and printed matter manufactured or imported before this date will also be given a period of not more than 12 months to dispose of stock if they comply with the provisions of the previous authorization.

This draft is expected to take effect from Jan 1st, 2023.

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Chemycal, 4-05-22

https://chemycal.com/news/6fea1a5b-e18c-4065-8bac-60d16871ae08/France_plans_to_ban_mineral_oil_in_packaging_and_printing

Proposal for limit value under CMRD due by end of 2024

Spain issues new regulations to promote plastic packaging recycling

2022-05-02

On March 31, 2022, Spanish Parliament passed the Law 7/2022 on waste and contaminated soil for a circular economy, banning the use of phthalates and bisphenol A in food packaging, supporting the reusability of food packaging.

The law aims to minimise the generation of waste, especially single-use plastics, and to manage the negative impact of packaging waste on human health and the environment, promoting the development of a

circular economy. This law replaces Law No. 22/2011 of 28 July 2011 on Waste and Contaminated Soils.

The food packaging part should pay attention to the following points:

- Ban on phthalates and bisphenol A in food packaging
- Restrict the types of plastic products on the market (including plastic products mentioned in Section IVB of the Annex to the Regulation; any plastic product made from oxidatively degradable plastic; plastic products with intentionally added microplastics smaller than 5 mm)
- Promote plastic recycling and application

This law runs into effect on April 9th, 2022.

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Chemycal, 2-05-22

https://chemycal.com/news/f020f420-1e72-4341-81a1-09ee893f1445/Spain_issues_new_regulations_to_promote_plastic_packaging_recycling

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REACH Authorisation List increased to 59

2022-04-22

On 11th April, EU published Commission Regulation (EU) 2022/586 to amend Annex XIV to Regulation (EC) No 1907/2006 (REACH).

This update is the 7th update of Annex XIV of the REACH Regulation, adding 5 chemical substances to the authorization list, which have reproductive toxicity, carcinogenicity or endocrine disrupting properties, which can be used as fuel additives, ink formulations, lubricants and polymers Stabilizers in biological production.

The 5 substances are:

- Tetraethyllead
- 4,4'-bis(dimethylamino)-4"-(methylamino)trityl alcohol (with ≥ 0,1 % of Michler's ketone (EC No 202-027-5) or Michler's base (EC No 202-959-2))
- Reaction products of 1,3,4-thiadiazolidine-2,5-dithione, formaldehyde and 4-heptylphenol, branched and linear (RP-HP) (with ≥ 0,1 % w/w 4-heptylphenol, branched and linear)
- 2-ethylhexyl 10-ethyl-4,4-dioctyl-7-oxo-8-oxa-3,5-dithia-4-stannatetradecanoate (DOTE)
- Reaction mass of 2-ethylhexyl 10-ethyl-4,4-dioctyl-7-oxo-8-oxa-3,5-dithia-4-stannatetradecanoate and 2-ethylhexyl 10-ethyl-4-[[2-[(2-ethylhexyl)oxy]-2-oxoethyl]thio]-4-octyl-7-oxo-8-oxa-3,5-dithia-4-stannatetradecanoate (reaction mass of DOTE and MOTE)

So far, the total number of substances in the authorized list has increased from 54 to 59.

The regulation will come into force on May 1.

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Chemycal, 28-04-22

https://chemycal.com/news/abd1f26b-dc1e-489a-8c43-de9541377208/REACH_Authorisation_List_increased_to_59

Unilever weighs in on 'backwards slide' in animal testing

2022-05-05

Unilever, the UK-based cosmetics and consumer goods conglomerate, has voiced its concerns about the need for animal tests in beauty.

The Dove owner has accused regulators of taking a "backwards slide", as contradicting laws leave a back door open for animal testing.

To meet the needs of the EU REACH regulation, chemicals companies may be forced to test cosmetic ingredients on animals in rare instances where a chemical's impact on human health or the environment is called into question.

In 2020, German chemicals company Symrise appealed a decision by the European Chemicals Agency (ECHA) that forced it to carry out tests on animals to satisfy REACH requirements, but was overruled by the Board of Appeal.

Under the EU Cosmetics Regulation (1223/2009), animal testing of cosmetic ingredients in the EU has been banned since March 2009, with an EU marketing ban on the sale of cosmetic ingredients tested on animals outside of the EU coming into effect in March 2013.

"While the EU Cosmetics Regulation forbids animal testing, the EU regulation which governs chemicals, known as REACH [...], still requires animal testing under many circumstances," the group wrote in a statement.

"This means there is a mismatch between the two regulations and so, while animal testing for cosmetics is banned in the EU, animal testing continues to take place under REACH.

"And the problem is getting worse.

"The European Chemicals Agency is calling for new animal tests for ingredients with a long history of safe use, even for those solely used in cosmetics.

"This move is destroying the EU's 2013 ban on animal testing for cosmetics."

However, Unilever has said that its scientific testing is able to predict a chemical's impact on the environment and ensure that it stays below harmful levels.

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This means it would be safe from animal tests to meet the requirements of chemical agency regulations.

And now, the company is calling for change in the way that chemical safety is assessed for regulatory purposes.

Read More

Cosmetics Business, 5-05-22

https://www.cosmeticsbusiness.com/news/article_page/Unilever_weighs_in_on_backwards_slide_in_animal_testing/200579

UK REACH – Restriction Proposals 004 - Lead shot in ammunition

2022-05-06

On 29 April 2021, the Health and Safety Executive (HSE) as the Agency for UK REACH received a request under Article 69(1) of UK REACH from the Defra Secretary of State, with the consent of the Scottish Government and the Welsh Government, to prepare an Annex 15 restriction dossier assessing the risks to the environment and human health from lead in ammunition (projectiles). In the European Union (EU), a restriction has been adopted for lead in gunshot over wetlands (January 2021), and a restriction for lead in shot, bullets and fishing weights is in progress. This Annex 15 dossier prepared by HSE examines whether a similar restriction should be introduced into Great Britain (GB; England, Scotland and Wales) covering lead in ammunition in all habitats.

In the request, Defra asked HSE to consider the risks posed by the use of lead in ammunition and the potential need for further risk management measures beyond those already in place. Lead-containing propellants, and police and military uses are outside of the scope defined by Defra.

Article 69(6) of UK REACH requires HSE to publish proposals for restrictions on its website and invite interested parties to submit comments on the proposed restriction within 6 months of the date of publication. This public consultation fulfils this requirement.

An additional 60-day consultation on the draft socioeconomic opinion will be held at a later stage to invite comments and to inform the development of the final socioeconomic opinion. People wishing to submit information during these public consultations are strongly advised to submit information as early as possible and not to limit their comments

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to this second consultation. Only socioeconomic factors will be taken into account during this second consultation period.

The following documents are attached to this consultation:

- The Annex 15 restriction dossier describing the risks to the environment and human health that lead creates if it is present in ammunition and the restriction options that HSE is proposing to manage these risks. This dossier also provides socioeconomic information to demonstrate that the proposed restriction options are effective, practical and monitorable.
- An additional annex which provides further details about the risks and the availability of alternative substances.

Read More

HSE, 6-05-22

https://consultations.hse.gov.uk/crd-reach/restriction-proposals-004

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Janet's Corner

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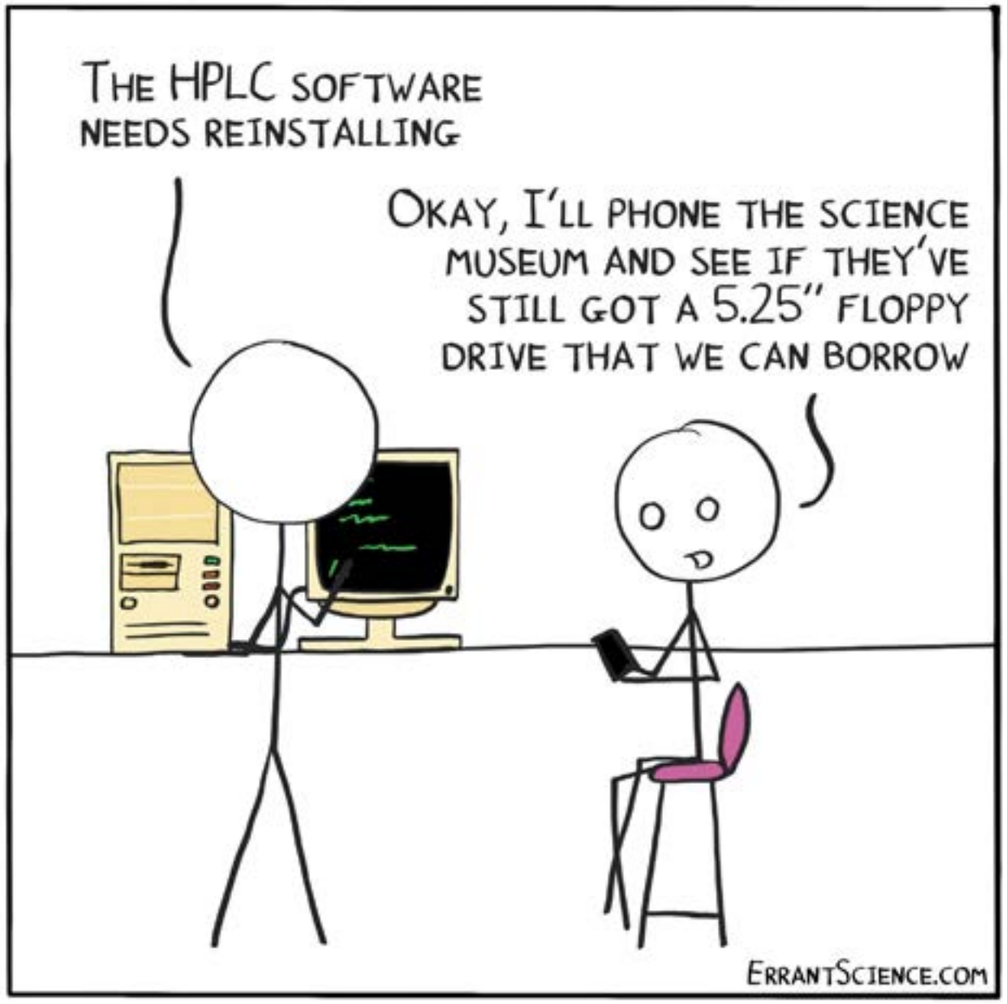
Science runs on computers from the 80s and 90s

2022-05-13



https://twitter.com/ErrantScience/status/1519666661435002881?cxt=HHwWgsCyvd2x-JYqAAAA

Sodium Nitrate

2022-05-13

Sodium nitrate—also known as Chile saltpeter—is an organic nitrate salt. It is a naturally occurring mineral and its chemical symbol is $NaN0^3$. At room temperature, the compound exists as a white crystalline solid. Sodium nitrate is highly soluble in water and ammonia and is non-flammable. The compound is a strong oxidising agent. When heated to temperatures above 538°C, the compound explosively decomposes. In the 19th century, sodium nitrate was known as "white gold". It has been categorised as the International Cancer Research Agency as likely to cause cancer to humans. [1]

USES [1]

Sodium nitrate is used in a number of different ways, including in the food, energy and gardening sectors. In the food industry, the compound is most commonly used as a preservative and as a way to add colour (usually red or purple) to processed meats. The compound is also used as an ingredient in several fertilisers; it also acts as an oxidiser in fireworks. Sodium nitrate can also be found in some instant ice packs. It is used in the transfer and storage of heat in solar panel plants and can be used as a substitute "ingredient" in gunpowder.

ROUTES OF EXPOSURE [3]

- Sodium nitrate is naturally found in fruits, vegetables and grains, including carrots, celery and spinach.
- High doses of sodium nitrate are usually found in crop fertilisers.
- Another route of high exposure is drinking water (both from a well and other sources), if nitrate compounds enter it.

HEALTH EFFECTS

Sodium nitrate poisoning affects a range of systems including the blood, cardiovascular and integumentary systems.

Acute Effects [3]

Severity of symptoms depend on the level and type of exposure.

- If there are high concentrations of sodium nitrate in fruits and vegetables, the first signs will show after four hours.

Sodium nitrate—also known as Chile saltpeter—is an organic nitrate salt.

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- If sodium nitrate is ingested, the symptoms will first show after an hour.
- A characteristic sign of (sodium) nitrate poisoning is brown-tinged blood in stool.
- Sodium nitrate exposure can also cause blue mucous membranes, nail beds and lips; nausea, vomiting, stomach cramps; yellowing of the white part of the eye and liver pain.

Chronic Effects [3]

Sodium nitrate is toxic to multiple body systems. Long-term exposure to the compound will cause a prolonged state of hypoxia. This will result in a disturbance to all tissues across the body. In children, hypoxia as a result of sodium nitrate poisoning results in delayed mental and physical development, impaired heart and blood vessel functioning, a decrease in the effectiveness of the immune system, and an increased irritability.

SAFETY

First Aid Measures [4]

· Ingestion: If sodium nitrate is ingested, rinse mouth and DO NOT induce vomiting. Immediately call a doctor or a poison centre.

· Skin contact: In case of skin or hair contact, remove/take off all contaminated clothing and immediately rinse exposed skin with mild soap and water. Do not re-wear clothing until it has been decontaminated. Call a poison centre.

· Eye contact: Rinse eyes carefully with water for several minutes. Check for and remove contact lenses if easy to do so. Continue rinsing. Only obtain medical attention if symptoms persist.

· Inhaled: Take victim to the nearest fresh air source and monitor their breathing. Allow them to rest and contact a medical professional.

· General: Never administer anything by mouth to an unconscious, exposed person.

Exposure Controls/Personal Protection [4]

· Engineering controls: Emergency eyewash fountains and safety showers should be accessible in the immediate area of the potential

exposure. Ensure there is adequate ventilation. Whenever possible, material should be handled in a laboratory.

· Personal protection: Safety glasses, protective and dustproof clothing, glove, an apron and an appropriate mask.

REGULATION [5]

United States:

The Occupational Safety and Health Administration (OSHA) has set an 8-hour time weighted average (TWA) concentration for sodium nitrate of 15mg/m^3.

Australia [6]

There is no specific TWA set for sodium nitrate. However, Safe Work Australia has set an 8-hour time TWA for dust limits of 10mg/m^3. It should be highlighted that the TWA values are likely to be higher than the biological standards exposure level for the compound; therefore, all reasonable steps must be taken to minimise the level of exposure to a level well below the workplace standard.

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Using BMI to measure your health is nonsense. Here's why

2022-05-01

We're a society obsessed with numbers, and no more so than when managing our health.

We use smartwatches to count steps and track our daily activity, creating scores for our fitness, and monitor our heart rate and sleep quality to measure our health and well-being.

Doctors can be just as obsessed with numbers, relying on measurements and equations to create scores for our health, one of the most popular of which is the Body Mass Index (BMI).

But BMI – a measure of the relationship between your weight and height – is increasingly under scrutiny. More and more experts are questioning its accuracy and health practitioners' fixation on using it as a single indicator of health and healthy weight.

Here's everything you need to know about BMI – and why using it as the sole measure of your health is nonsense, starting with a quick history lesson.

Where did BMI come from, and why is it associated with health?

The concept of BMI was developed in 1832 (yes, almost 200 years ago!) by Belgian statistician Lambert Adolphe Quetelet, who was called on to create a description of the "average man" to help the government estimate obesity numbers among the general population.

Fast-forward 100 years to the United States, where life insurance companies had started comparing people's weight to an average population weight for similar individuals to calculate insurance premiums based on a predicted risk of dying.

Annoyed by this somewhat unscientific approach, US physiologist Ancel Keys completed research with 7,000 healthy men using Quetelet's measure, finding this method was a more accurate and simpler predictor of health that was also inexpensive.

Quetelet's calculation was subsequently renamed BMI and adopted as a primary indicator of health, thanks to subsequent studies confirming increased risks of heart disease, liver disease, arthritis, some cancers, diabetes and sleep apnoea with increased BMI.

Numerous studies have found people with the same BMI can have very different disease risk profiles, primarily driven by where fat is distributed in their bodies. This is because not all fat is equal.

Its use soon became widespread, and today, BMI is found everywhere, from the doctor's surgery to the gym.

How is BMI measured, and what do the scores mean?

The BMI formula is simple, and easy to calculate thanks to the many free BMI calculators available online.

To calculate BMI:

take your weight in kilograms

to get your index, divide your weight by the square of your height in metres.

Your result classifies you into one of four categories describing your body weight in a single word:

- underweight – a BMI of less than 18.5
- normal – a BMI between 18.5 and 24.9
- overweight – a BMI between 25.0 and 29.9
- obese – a BMI of 30 or above.

So is BMI an accurate measure of health?

In short: no.

While BMI is an accessible and affordable way to screen a person's health, it shouldn't be relied on as a single measure of health.

Here's why.

1. BMI misses a more important measure – body fat percentage

BMI is based on body weight, but a person's disease risk is linked to body fat, not weight.

While body weight can be a proxy for body fat, there's an important reason it doesn't always tell an accurate story: muscle is much denser than fat.

Because BMI calculators can't differentiate fat from muscle, people can be easily misclassified. At the extreme, BMI has classified athletes in peak fitness condition, such as sprinter Usain Bolt, as almost overweight, and American footballer Tom Brady as obese.

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2. BMI does not measure body fat distribution

Numerous studies have found people with the same BMI can have very different disease risk profiles, primarily driven by where fat is distributed in their bodies. This is because not all fat is equal.

If you have fat stored around your stomach, your risk of chronic disease is much higher than people who have fat stored around their hips, because this is an indicator of how much visceral fat you have – the type of fat deep inside the belly that increases your risk of stroke, type 2 diabetes and heart disease.

In white populations, a waist circumference of more than 80cm for women and more than 94cm for men is associated with an increased risk of chronic disease, and for Asian populations it is more than 80cm for women or 90cm for men.

3. BMI does not account for demographic differences

The BMI is something none of us like – racist and sexist.

When Quetelet created and Keys validated BMI, they studied largely male, middle-aged Anglo-Saxon populations. Their method prevails, even though BMI's calculations and classifications are used universally today.

Our bodies, by nature, have some distinct characteristics driven by our gender, including that females generally have less muscle mass and more fat mass than males. We also know muscle mass decreases and shifts around the body as we age.

Research has also confirmed significant differences in body weight, composition and disease risk based on ethnicity. This includes findings from the early 2000s that found on measures for optimum health, people of Asian ethnicity should have a lower BMI, and people of Polynesian ethnicity could be healthier at higher BMIs.

This issue has led to suggested redefined BMI cut-off points for people of Asian ethnicity (where a healthy BMI is less than 23) and Polynesians (where a healthy BMI is less than 26).

So what should we be using instead?

To be clear: weight and health are related, with countless studies demonstrating people who are obese or overweight have an increased risk of disease.

But while BMI can be used as a screening tool, it shouldn't be the only tool relied on to assess a person's health and healthy weight.

Instead, we need to focus on measures that tell us more about fat in the body and where it's distributed, measuring weight circumference, waist-to-hip ratios and body fat to get a better understanding of health and risk.

We also need to consider the many other ways to measure your health and likelihood of disease, including levels of triglycerides (a type of fat found in your blood), blood pressure, blood glucose (sugar), heart rate, presence of inflammation, and stress levels.

As a single measure, BMI is not a good measure of health – it lacks accuracy and clarity and, in its current form, misses measuring the many important factors that influence your risk of disease.

Although BMI can be a useful starting point for understanding your health, it should never be the only measurement you use.

The Conversation, 1 May 2022

https://theconversation.com

Scientists discover how bees activate natural medicine against parasite infection during pollination

2022-05-01

In a new paper published today in a special issue of Philosophical Transactions of The Royal Society, Kew scientists and partners report on how bees activate the "medicinal" properties of various nectars to protect themselves from parasite infections.

The team of researchers led by Kew scientist Dr. Hauke Koch, in partnership with Professor Mark Brown at Royal Holloway, University of London, collected nectar and pollen samples from linden and strawberry trees at Kew Gardens in West London to determine how bees process the beneficial compounds found within. The researchers found that two compounds naturally found in the nectars of these species are activated by the bees' digestive processes, the gut microbiome (microorganisms) or a combination of both.

The study's primary aim was to discover how these elements and their anti-parasitic qualities can protect bees from the common gut parasite Crithidia bombi. The experiments yielded promising results for bee conservation efforts at a time when pollinators face the increasing threat

By better understanding the functional importance and contributions of individual members of the microbiome to different pollinators, we may in the future be able to better support their health.

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of decline from climate change, disease, and habitat loss due to agriculture and land use.

Pollination by animals is one of the world's most important species interactions, as plants offer a nutritious reward to insects, birds, and small mammals in exchange for the transfer of pollen. Not only does this process facilitate the reproduction of many plants, but it also serves to support global food production and ecosystems. Scientists are, therefore, alarmed to see mounting evidence of declines in pollinator abundance and diversity.

Among the threats faced by pollinators today are the dangers posed by parasites. Bee parasites can be introduced and spread through global trade routes, and can spill over from managed honeybee colonies to wild pollinators. Their effects on bees are worsened by other stress factors such as pesticide use affecting microbiome health. The bumblebee gut parasite C. bombi is of special interest to scientists, as the parasite is common and known to threaten the survival and development of bumble colonies.

Dr. Hauke Koch, Research Leader in Pollinator Biological Chemistry at RBG Kew and lead author of the paper, says, "Pollinators have diverse microbiomes in their guts and nest environments. These communities of microorganisms can be important for the health of pollinators, for example by defending them against diseases or producing important nutrients. By better understanding the functional importance and contributions of individual members of the microbiome to different pollinators, we may in the future be able to better support their health.

"For example, managed honeybee and bumblebee colonies can be supported through novel probiotics, or healthy microbiomes in wild pollinators can be maintained through a restriction in pesticides that negatively affect the microbiome and through the promotion of plants with nectar or pollen chemistry that stimulate healthy microbiomes."

The first compound analyzed by the team, unedone, was found in the nectar of strawberry trees (Arbutus unedo) and was extracted from strawberry tree honey. The evergreen, shrubby tree is native to Ireland, Western Europe and the Mediterranean, and commonly planted in parks and gardens in the UK. Its nectar and pollen-rich flowers are known to be an important food for bumblebees in the autumn. Honeybees produce a bitter-tasting honey from it that is sought after around the Mediterranean.

The compound unedone was tested on C. bombi cultures grown in a lab as well as on buff-tailed bumblebee (Bombus terrestris) gynes (female

bees capable of reproduction) collected at Kew in the autumn of 2018. The latter part of the experiment saw the researchers feed the bees a mix of sugar syrup and pollen over a two-week period, after which their feces were screened for parasites. Select bees were then given a treatment of sugar syrup or a treatment of unedone. The compound was found to inhibit C. bombi infections but only after interacting with the microbiome, as the initial metabolic processes in the mid-gut rendered it inactive against the parasite.

The researchers also determined that tiliaside, a compound extracted from the nectar of the linden tree, offers similar benefits to buff-tailed bumblebee workers. However, in contrast to unedone, tiliaside was found to be activated by the bees' own digestive processes. Both compounds have been put forward as evidence of the benefits that food and microbiomes hold for protecting and strengthening pollinator health—at an individual and community level.

Professor Phil Stevenson, Head of Trait Diversity and Function at RBG Kew, and study co-author, says, "Understanding the drivers of pollinator health—both good and bad—is critical to realizing how we can best support pollination services and continue to benefit from their contributions to food production and sustaining natural ecosystems.

"We now know that some flowers provide better nutrition for some species while others provide bees with a natural medicine, so we can select plants for restoring degraded landscapes or crop field margins that provide multiple and tailored benefits to pollinators enhancing their health from individual through to community level."

In addition to the dangers posed by parasites, pollinator decline is being driven by pesticide use, the intensification of agriculture, and climate change. Scientists are thus keen to better understand the natural processes that influence and affect pollinator health—both positively and negatively. These processes include the nutritional quality of pollen and nectar, the impact of parasites and the benefits of the microbiome, as well as the effects of natural bioactive compounds and landscape structure.

Stevenson adds, "The impacts of human activities on pollinator health and decline through excessive pesticide use, climate change and agricultural intensification are now widely accepted after decades of evidence gathering.

"We now need to look for solutions and ways of sustaining diverse and healthy populations of pollinators and other insect groups. Many of

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these solutions can be developed through a better understanding of the natural processes that influence pollinator health. If we know how nutrition varies across the pollen of different species and which species provide the best food resources for the widest range of pollinating species, we can implement restoration programs such as field margin planting and ecological corridors with much better accuracy to the species of importance and with long-term benefits."

Phys Org, 1 May 2022

https://phys.org

Social media break improves mental health, according to a new study

2022-05-05

Asking people to stop using social media for just one week could lead to significant improvements in their well-being, depression and anxiety, and could in the future be recommended as a way to help people manage their mental health, say the authors of a new study.

The study, carried out by a team of researchers at the University of Bath (UK), studied the mental health effects of a week-long social media break. For some participants in the study, this meant freeing up around nine hours of their week that they would otherwise have been spent scrolling Instagram, Facebook, Twitter and TikTok.

The results—published today in the US journal Cyberpsychology, Behavior and Social Networking—suggest that just one week off social media improved individuals' overall level of well-being, as well as reducing symptoms of depression and anxiety.

For the study, the researchers randomly allocated 154 individuals aged 18 to 72, who used social media every day, into either an intervention group where they were asked to stop using all social media for one week, or a control group, where they could continue scrolling as normal. At the beginning of the study, baseline scores for anxiety, depression and well-being were taken.

Participants reported spending an average of 8 hours per week on social media at the start of the study. One week later, the participants who were asked to take the one-week break had significant improvements in well-being, depression, and anxiety over those who continued to use social media, suggesting a short-term benefit.

"Many of our participants reported positive effects from being off social media with improved mood and less anxiety overall. This suggests that even just a small break can have an impact."

Participants asked to take a one-week break reported using social media for an average of 21 minutes compared to an average of seven hours for those in the control group. Screen usage stats were provided to check that individuals had adhered to the break.

Lead researcher from Bath's Department for Health, Dr. Jeff Lambert, explains, "Scrolling social media is so ubiquitous that many of us do it almost without thinking from the moment we wake up to when we close our eyes at night.

"We know that social media usage is huge and that there are increasing concerns about its mental health effects, so with this study, we wanted to see whether simply asking people to take a week's break could yield mental health benefits.

"Many of our participants reported positive effects from being off social media with improved mood and less anxiety overall. This suggests that even just a small break can have an impact.

"Of course, social media is a part of life and for many people, it's an indispensable part of who they are and how they interact with others. But if you are spending hours each week scrolling and you feel it is negatively impacting you, it could be worth cutting down on your usage to see if it helps."

The team now want to build on the study to see whether taking a short break can help different populations (e.g., younger people or people with physical and mental health conditions). The team also want to follow people up for longer than one week, to see if the benefits last over time. If so, in the future, they speculate that this could form part of the suite of clinical options used to help manage mental health.

Over the past 15 years, social media has revolutionized how we communicate, underscored by the huge growth the main platforms have observed. In the UK the number of adults using social media increased from 45% in 2011 to 71% in 2021. Among 16 to 44-year-olds, as many as 97% use social media and scrolling is the most frequent online activity performed.

Feeling "low" and losing pleasure are core characteristics of depression, whereas anxiety is characterized by excessive and out-of-control worry. Well-being refers to an individual's level of positive affect, life satisfaction and sense of purpose. According to the UK organization Mind, one in six

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individuals experience a common mental health problem like anxiety and depression in any given week.

Medical Xpress, 5 May 2022

https://medicalxpress.com

Blasting out Earth's location with the hope of reaching aliens is a controversial idea – two teams of scientists are doing it anyway

2022-04-29

If a person is lost in the wilderness, they have two options. They can search for civilization, or they could make themselves easy to spot by building a fire or writing HELP in big letters. For scientists interested in the question of whether intelligent aliens exist, the options are much the same.

For over 70 years, astronomers have been scanning for radio or optical signals from other civilizations in the search for extraterrestrial intelligence, called SETI. Most scientists are confident that life exists on many of the 300 million potentially habitable worlds in the Milky Way galaxy. Astronomers also think there is a decent chance some life forms have developed intelligence and technology. But no signals from another civilization have ever been detected, a mystery that is called "The Great Silence."

Most scientists are confident that life exists on many of the 300 million potentially habitable worlds in the Milky Way galaxy.

While SETI has long been a part of mainstream science, METI, or messaging extraterrestrial intelligence, has been less common.

I'm a professor of astronomy who has written extensively about the search for life in the universe. I also serve on the advisory council for a nonprofit research organization that's designing messages to send to extraterrestrial civilizations.

In the coming months, two teams of astronomers are going to send messages into space in an attempt to communicate with any intelligent aliens who may be out there listening.

These efforts are like building a big bonfire in the woods and hoping someone finds you. But some people question whether it is wise to do this at all.

The history of METI

Early attempts to contact life off Earth were quixotic messages in a bottle.

In 1972, NASA launched the Pioneer 10 spacecraft toward Jupiter carrying a plaque with a line drawing of a man and a woman and symbols to show where the craft originated. In 1977, NASA followed this up with the famous Golden Record attached to the Voyager 1 spacecraft.

These spacecraft – as well as their twins, Pioneer 11 and Voyager 2 – have now all left the solar system. But in the immensity of space, the odds that these or any other physical objects will be found are fantastically minuscule.

Electromagnetic radiation is a much more effective beacon.

Astronomers beamed the first radio message designed for alien ears from the Arecibo Observatory in Puerto Rico in 1974. The series of 1s and 0s was designed to convey simple information about humanity and biology and was sent toward the globular cluster M13. Since M13 is 25,000 light-years away, you shouldn't hold your breath for a reply.

In addition to these purposeful attempts at sending a message to aliens, wayward signals from television and radio broadcasts have been leaking into space for nearly a century. This ever-expanding bubble of earthly babble has already reached millions of stars. But there is a big difference between a focused blast of radio waves from a giant telescope and diffuse leakage – the weak signal from a show like "I Love Lucy" fades below the hum of radiation left over from the Big Bang soon after it leaves the solar system.

Sending new messages

Nearly half a century after the Arecibo message, two international teams of astronomers are planning new attempts at alien communication. One is using a giant new radio telescope, and the other is choosing a compelling new target.

One of these new messages will be sent from the world's largest radio telescope, in China, sometime in 2023. The telescope, with a 1,640-foot (500-meter) diameter, will beam a series of radio pulses over a broad swath of sky. These on-off pulses are like the 1s and 0s of digital information.

The message is called "The Beacon in the Galaxy" and includes prime numbers and mathematical operators, the biochemistry of life, human forms, the Earth's location and a time stamp. The team is sending the message toward a group of millions of stars near the center of the Milky Way galaxy, about 10,000 to 20,000 light-years from Earth. While

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this maximizes the pool of potential aliens, it means it will be tens of thousands of years before Earth may get a reply.

The other attempt is targeting only a single star, but with the potential for a much quicker reply. On Oct. 4, 2022, a team from the Goonhilly Satellite Earth Station in England will beam a message toward the star TRAPPIST-1. This star has seven planets, three of which are Earth-like worlds in the so-called "Goldilocks zone" – meaning they could be home to liquid and potentially life, too. TRAPPIST-1 is just 39 light-years away, so it could take as few as 78 years for intelligent life to receive the message and Earth to get the reply.

Ethical questions

The prospect of alien contact is ripe with ethical questions, and METI is no exception.

The first is: Who speaks for Earth? In the absence of any international consultation with the public, decisions about what message to send and where to send it are in the hands of a small group of interested scientists.

But there is also a much deeper question. If you are lost in the woods, getting found is obviously a good thing. When it comes to whether humanity should be broadcasting a message to aliens, the answer is much less clear-cut.

Before he died, iconic physicist Stephen Hawking was outspoken about the danger of contacting aliens with superior technology. He argued that they could be malign and if given Earth's location, might destroy humanity. Others see no extra risk, since a truly advanced civilization would already know of our existence. And there is interest. Russian-Israeli billionaire Yuri Milner has offered $1 million for the best design of a new message and an effective way to transmit it.

To date, no international regulations govern METI, so the experiments will continue, despite concerns.

For now, intelligent aliens remain in the realm of science fiction. Books like "The Three-Body Problem" by Cixin Liu offer somber and thought-provoking perspectives on what the success of METI efforts might look like. It doesn't end well for humanity in the books. If humans ever do make contact in real life, I hope the aliens come in peace.

The Conversation, 29 April 2022

https://theconversation.com

Beyond electric cars: how electrifying trucks, buses, tractors and scooters will help tackle climate change

2022-05-03

When you think of an electric vehicle, chances are you'll picture a car. But there's a quiet revolution going on in transport. It turns out electrification can work wonders for almost all of our transport options, from electric bikes to motorbikes to buses to freight trains and even to tractors and heavy trucks. There will soon be no need to burn petrol and diesel in an internal combustion engine.

This matters, because electric transport will be vital in our efforts to stem climate change. If all cars on the road became powered by renewable electricity, we'd cut almost one-fifth of our emissions. We'd also be much better placed to weather spikes in oil prices linked to war, and enjoy cleaner air and quieter cities.

It's promising news that electric vehicles are shaping up as an election issue at last, with Labor promising a national EV charging network at its campaign launch, and the Greens promising rebates of up to $15,000 for EV purchases, while the Liberal Party last year reversed its previous scepticism and launched a smaller charging network policy.

But this is only the beginning of what's required. Right now, all the focus is on electric cars. We will need new policy settings to encourage the electrification of all our transport options. And that means getting electric mobility on the radar of our political parties.

Why electric and why now?

Electric vehicles have been around for more than 120 years. They accounted for a third of all cars on US roads in 1900, sought because they were clean and quiet. But their first dawn ended because of the high cost and weight of batteries, leaving internal combustion engines to rule the road.

So what changed? Two things: solar has become the cheapest form of power in human history, and lighter lithium-ion batteries have become vastly cheaper. These remarkable inventions have allowed electric vehicle manufacturers to become competitive. Cheap solar power funnels into the battery of the electric vehicle to provide running costs much lower than those of fossil fuel engines. The much simpler engines also mean vastly lower maintenance costs.

Even tractors are going electric, with a key marketing point the ability for farmers to recharge through their own solar arrays.

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We're also seeing major innovations brought across from electric public transport. Over the past two decades, there have been significant advances in smart technology in trains and trams, such as regenerative braking and sensors enabling active suspension. These breakthroughs have been taken up enthusiastically by electric vehicle manufacturers. All electric cars now have regenerative braking, which hugely increases energy efficiency, as well as smart sensors to aid steering, and active suspension, making the cars safer and the ride smoother.

We're also seeing welcome cross-pollination in the form of trackless trams, which are upgraded buses that boast rail-like mobility. This is made possible based on technologies invented for high-speed rail.

In short, there's no reason why solar and battery technology has to be limited to cars. All the world's land-based internal combustion engine vehicles can now be replaced by electric equivalents.

Electric mobility is arriving

You'll already have seen signs of the potential of electric mobility. E-scooters are popping up in major cities, giving people a way to make short trips quickly and cheaply. E-bikes are surging ahead, popular among commuters and families choosing one over a second car. Even this is just the start.

Around the world, electric micromobility (scooters, skateboards and bikes) is growing at over 17% per year and expected to quadruple current sales of US$50 billion by 2030.

Even without much government assistance, Australians are shifting rapidly to all types of electric vehicle. But for Australia to embrace electric transport as fully as we can, we need the right policy settings. Cars, scooters, motorbikes, trackless trams, buses, trucks, freight trains and farm vehicles can all be part of the transition to the cheapest and highest-quality mobility the world has yet seen.

The policies on offer to date suggest no party has figured out the radical upheaval electrification will bring. Labor's emission reductions policy of a 43% cut by 2030 gives electric cars only a tiny role, cutting emissions by less than 1%, or four million tonnes out of a total of 448 million tonnes. There's no mention of other electric modes of transport. Even the Greens have little serious policy analysis of the broader EV options. The Liberals have no mention at all.

We need comprehensive, broad electric vehicle policy

Given we're still at the starting line, what's the best first step? Perhaps the simplest would be to enable Infrastructure Australia to work with the states on creating strategic directions for each electric transport mode. The ACT already has a plan like this for its bus network as part of its shift to a zero-carbon future.

Here's what good EV policies would consider:

- Electric micromobility: how to recharge and manage the explosion of electric scooters, skateboards and bikes with appropriate infrastructure, and how to enable the best public sharing systems
- Electric public transit: how to electrify all buses, passenger trains and mid-tier transit (light rail, rapid transit buses and trackless trams), and how to link net zero urban developments and charging facilities
- Electric trucks, freight trains and farm vehicles: how to create recharge highways and hubs in train stations, industrial precincts and standalone farm systems, and how to introduce these to the regions to enable net zero mining, agriculture and other processed products.

Each of these modes will also need the same targets, subsidies and regulations as electric cars do, to make possible a swift, clean transition away from petrol and diesel. If we focus only on electric cars, we could end up with cities still full of cars, even if they don't pollute. By focusing on all transport modes, we will make our cities more equitable, safe and sustainable.

The Conversation, 3 May 2022

https://theconversation.com

MicroRNA and Immune System Play Key Roles in Sleep Regulation

2022-05-02

Hypocretin is a protein suspected to play a role in both insomnia, which is a decreased ability to fall asleep at night, and in narcolepsy, which is a decreased ability to stay awake during the day. People suffering from insomnia may have too much hypocretin in the brain, while people suffering from narcolepsy have too little. Researchers also suspect hypocretin to play a role in depression, ADHD, and other mental disorders.

Although much is already known about the hypocretin system in the brain, little is understood on how hypocretin is regulated inside the cells,

Hypocretin is a protein suspected to play a role in both insomnia, which is a decreased ability to fall asleep at night, and in narcolepsy, which is a decreased ability to stay awake during the day.

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according to Birgitte Kornum, PhD, associate professor in the department of neuroscience, the faculty of health and medical sciences, University of Copenhagen who, along with colleagues, has published a study ("The evolutionarily conserved miRNA-137 targets the neuropeptide hypocretin/orexin and modulates the wake to sleep ratio") in PNAS. The research combines tests on mice, zebrafish, and human cells.

MicroRNA associated with sleep regulation

The team has spent a number of years of researchers studying one of the cellular mechanisms that affect hypocretin levels. In the current research paper, they focused on microRNA-137 (miR-137).

Hypocretin (Hcrt), also known as orexin, neuropeptide signaling stabilizes sleep and wakefulness in all vertebrates. A lack of Hcrt causes the sleep disorder narcolepsy, and increased Hcrt signaling has been speculated to cause insomnia, but while the signaling pathways of Hcrt are relatively well-described, the intracellular mechanisms that regulate its expression remain unclear," write the investigators.

"Here, we tested the role of microRNAs (miRNAs) in regulating Hcrt expression. We found that miR-137, miR-637, and miR-654-5p target the human HCRT gene. miR-137 is evolutionarily conserved and also targets mouse Hcrt as does miR-665. Inhibition of miR-137 specifically in Hcrt neurons resulted in Hcrt upregulation, longer episodes of wakefulness, and significantly longer wake bouts in the first 4 h of the active phase.

"IL-13 stimulation upregulated endogenous miR-137, while Hcrt mRNA decreased both in vitro and in vivo. Furthermore, knockdown of miR-137 in zebrafish substantially increased wakefulness.

"Finally, we show that in humans, the *MIR137* locus is genetically associated with sleep duration. In conclusion, these results show that an evolutionarily conserved miR-137:Hcrt interaction is involved in sleep–wake regulation."

"We discovered that miR-137 helps regulate hypocretin. To experience normal sleep, you need to have the right amount of hypocretin in the brain at the right time, and miR-137 helps with that. Though MiR-137 is also found in other parts of the body, it is especially pronounced in the brain," said Kornum.

MicroRNA regulates various cellular processes, including hypocretin levels. Therefore, there is considerable research interest in microRNAs, as they could be targeted in order to regulate such processes.

Previously, the scientists knew little about the role played by miR-137 in the brain, but now Kornum's research team has demonstrated that it is associated with hypocretin regulation and thus with sleep.

"This is the first time a microRNA is associated with sleep regulation," she explained. "Drawing on the UK Biobank, we discovered some genetic mutations in miR-137 which cause daytime sleepiness. The study demonstrates this connection in both mice and zebrafish, and we are able to prove the connection with hypocretin. Our discovery shows just how complex the machinery of sleep is. Imagine inheriting a variant of miR-137 that puts you at higher risk of feeling sleepy during the day."

Hypocretin affects sleep stages

Hypocretin, which has caught the attention of pharmaceutical companies, also affects the order of the four sleep stages, which follow a specific order that is vital to the quality of sleep.

"Narcolepsy patients suffering from low levels of hypocretin experience muddled sleep stages. We know this from mice tests demonstrating that hypocretin affects the order of these stages," said Anja Holm, PhD, from Aalborg University, who is first author of the study and who did the tests together with Kornum.

Existing research suggests that to solve the problem we need to gain more knowledge of hypocretin regulation. Here the Danish researchers point to a different, but equally important piece of the puzzle, i.e., the immune system.

"Most people know that when you are ill you often feel tired. And when you have a fever and the immune system is hard at work, you often suffer from poor sleep. So we know that something happens to the hypocretin level when the body is trying to fight off a virus infection, for example, and we are trying to understand this process," noted Kornum.

"In the study, we show that one of the immune system's transmitter substances, IL-13, has a special effect on hypocretin. We can tell that when we add IL-13, it affects miR-137 and thus also the level of hypocretin in the body. We still do not know why, though, but we are currently doing tests that may be able to give us an answer."

GenEng News, 2 May 2022

https://genengnews.com

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Climate change is pushing toxic chemicals into drinking wells

2022-05-02

Don Myron is probably best known as the guy who survived one of the deadliest fires in Oregon's history by sheltering overnight in a river with a patio chair. So there was never any question that Myron would rebuild his home in Oregon's Santiam Canyon after the house was destroyed in the Labor Day wildfires of 2020.

The well Myron shared with nearby homeowners was no longer available, which meant one of his first tasks was to drill his own new source for drinking water.

"It's hard to rebuild without water," Myron said. "It's hard to do anything without water. It was a priority."

But with climate change confronting communities across the West, people who rely on wells are at particular risk as wildfires grow in intensity and frequency. Without vegetation, fire-scarred land becomes more susceptible to mudslides that can damage watersheds. Drought can increase the concentration of pathogens and other contaminants in well water. And fires can damage the well equipment and piping, leaching toxic chemicals into drinking water and forcing property owners to consider costly repairs, upgrades and filtering systems even as they rebuild their homes and businesses. Beyond the West, heavier rains and floods threaten well water quality, too.

In Oregon, about a quarter of state residents rely on private wells for their water supply, according to the Oregon Health Authority. An estimated 2,000 households that rely on private wells were affected by the Labor Day fires of 2020, which, fueled by severe windstorms, rank among the largest and deadliest fires ever experienced in the state. In response, the state established a free voucher program that pays for people affected by the Labor Day fires to test their well water for some contaminants.

Once Myron's well was drilled and operational, he used the voucher to have the water tested. It was "as clean as could be," Myron said. "I was pleasantly surprised."

Such testing is increasingly common in Western states. After the 2018 Camp Fire nearly destroyed the town of Paradise in northern California, the Butte County Health Department warned residents that creeks and rivers flowing from fire-affected areas could contain elevated levels of heavy

About 90% of nitrate contamination comes from manure and commercial fertilizer application. When heavy rainstorms dump water, they wash away the fertilizer on farm fields.

metals such as arsenic, a carcinogen, and lead, a neurotoxin. The fires damaged municipal systems and an estimated 2,438 private wells in what is, for now, the deadliest and most destructive wildfire in California history.

The county also alerted property owners that contaminants could seep into the aquifers tapped by private wells. Butte County not only warned people to test for contaminants, but also advised them to drink pricey bottled water until they knew the full extent of the fire damage to their wells.

If a fire burned or damaged the casing or plumbing around a well, officials warned, such breaches could cause bacterial growth, including E. coli, which can cause severe gastrointestinal distress. Heat damage from the fires also can compromise the plastic components of wells, potentially leaching dangerous chemicals into drinking water.

Many of the fire-scarred communities of the West now are using guidelines developed in part by researcher Andrew Whelton, an engineering professor at Purdue University and director of the school's Center for Plumbing Safety. Whelton studies water safety after wildfires, most recently after the Marshall Fire in suburban Boulder, Colorado.

Health departments and state regulators needed a baseline understanding of what they should tell property owners, Whelton said, and in many cases were too overwhelmed by the logistics of disaster management to develop their own.

"The people that were most affected by the contamination, the people that were receiving water that may or may not be contaminated, they may or may not have contaminated plumbing," Whelton said. "They didn't have any single authority to go to, to get advice."

Most of the states that require that private wells be inspected or tested for integrity or water quality only do so when they're first drilled or when a property changes hands. It's generally up to an individual homeowner to pay to maintain a well and monitor its water quality.

As a result, few wells are tested regularly. Polling shows that many Americans care deeply about water quality. But despite highly visible water crises, including high lead levels in Flint, Michigan, and scarcity within the Navajo Nation, the quality and safety of drinking water often are taken for granted. People turn on their taps and expect it to be fine.

In Oregon, only about 200 property owners with private wells have sought testing vouchers following the 2020 fires, said Curtis Cude, manager of the

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Oregon Health Authority's domestic well safety program. Public health officials expected more people to apply for the vouchers, though they acknowledge that, because repairs can be expensive, wells may be a lower priority for some families.

"One of the things that we were hearing, especially last year, is that people were still buried in ash and debris," Cude said. "And some of those properties were so extensively damaged that they hadn't the opportunity to even think about getting their well on line."

Nationwide, an estimated 40 million people obtain their drinking water from a domestic well, according to estimates by the U.S. Geological Survey. Many of those people are in rural communities not serviced by municipal water systems. In the West, homes with private wells are often in the places most vulnerable to increasingly hot or intense wildfires or the effects of drought.

In states prone to wildfire, water quality remains an existential threat. The burden of sourcing uncontaminated water can be particularly stressful on people who've survived a wildfire.

For example, Whelton points to a study of attitudes about water safety, which surveyed 233 households in Butte County, California, after the Camp Fire. More than half of respondents, 54%, self-reported that at least one member in their household had anxiety, stress or depression directly related to securing water, or in connection with water contamination issues. Most people who were surveyed said uncertainty about water and plumbing safety prompted them to alter water use in their homes. About 47% installed in-home water treatment technologies; 85% said they sought out alternate water sources.

Yet well contamination is a problem all over the country, including in places where climate change means more frequent and more intense rain events. In the Midwest, the intensity and frequency of rainstorms has increased since 1901, according to the most recent National Climate Assessment. It's projected only to get worse. Heavy rains can overwhelm sewer or septic systems, transporting pathogens to the groundwater drawn up by wells.

In 2018, hurricanes Florence and Michael inundated coastal Florida, Georgia and the Carolinas, dumping more than 30 inches of rain in some places. The storms affected as many as 730,000 wells in the region, according to estimates from the National Groundwater Association. In North Carolina, the rains from Florence flooded more than 30 hog lagoons

full of pig waste. The overflowing toxic muck from floodwaters can seep into the aquifer or make its way down into wells from flooding at the surface.

In the wake of the storms, North Carolina tested 1,000 private wells, said Wilson Mize, a regional environmental health specialist with the N.C. Department of Health and Human Services. After Hurricane Florence, 13% of the wells tested were positive for E. coli. Typically, with new wells, only about 3% test positive for it. The results gave health officials a good indication that floodwater was entering the wells, Mize said. The positive results for E. coli dropped to about 3% after wells were disinfected.

The numbers provided state health officials a baseline for the effects of flood-related pollution on wells, which is a matter of critical public health concern—about 2.4 million people rely on wells for drinking water in the state. Since 2018, North Carolina has developed a program to get information out to people with wells who face heavy rainstorms. In areas with many wells, county officials place door hanger pamphlets with information about how to care for a well before and after a storm.

Along with NASA and a researcher at Northeastern University, North Carolina is developing a well water surveillance and response system. It will create a mapping tool that, after flooding, will pinpoint the areas in the state with private wells. It's aimed at helping the state determine where to emphasize sampling and disinfection after hurricanes, tropical storms and other heavy rains.

In parts of the Midwest, nitrate pollution from fertilizer is especially troublesome after heavy rains, said Scott Laeser, the water program director for Clean Wisconsin, an environmental nonprofit. About a third of Wisconsin residents draw their drinking water from private wells, Laeser said.

About 90% of nitrate contamination comes from manure and commercial fertilizer application. When heavy rainstorms dump water, they wash away the fertilizer on farm fields. Nitrates are especially mobile, and, once rainwater saturates the ground, the compounds quickly descend into the groundwater. Then, the chemicals reemerge in people's well water. Nitrates are most notable for causing what's known as blue baby syndrome, a condition that results in low oxygen levels in the blood.

The threat of well pollution from manure is so severe that the state of Wisconsin operates an online risk advisory forecast to help farmers understand how weather conditions and soil temperatures might

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exacerbate runoff. It is updated three times a day by the National Weather Service.

Laeser said the conservation work conducted by Clean Wisconsin to prevent runoff has been based on the assumptions of past climate patterns, not a present and future in which major rainstorms are increasingly frequent. The group's conservation measures in the state weren't enough before, he said, but now, they look "increasingly inadequate in the face of the extreme weather challenges that we're facing."

"What we are having to do is kind of toss those out because they aren't relevant anymore," Laeser said. "Places in western and northern Wisconsin are getting 100- and 500-year storms annually or biannually."

Agriculture has the potential to be a big part of climate solutions, Laeser said. Synthetic fertilizer production uses fossil fuels, in particular natural gas. Heavy fertilizer use contributes to greenhouse gas emissions.

Reducing synthetic fertilizer use helps both the climate and water quality, Laeser said. So does finding ways for farms to be financially resilient and sustainable—including incentivizing growers to set aside wetlands—that don't "solely reward them based on as much cheap food as possible."

"There's a huge opportunity in that we can address so many water and climate challenges simultaneously," Laeser said. "The connections between our water and climate challenges are becoming clearer by the day."

Phys Org, 2 May 2022

https://phys.org

Study of promising Alzheimer's marker in blood prompts warning about brain-boosting supplements

2022-05-03

Elevated levels of an enzyme called PHGDH in the blood of older adults could be an early warning sign of Alzheimer's disease, and a study led by the University of California San Diego provides new evidence to support this claim. In analyzing brain tissue, researchers observed a trend consistent with their previous findings in blood samples: expression levels of the gene coding for PHGDH were consistently higher in adults with different stages of Alzheimer's disease, even the early stages before cognitive symptoms manifested.

"Now we have strong evidence that the changes we see in human blood are directly correlated to changes in the brain in Alzheimer's disease."

The findings also prompt caution against the use of dietary supplements that contain the amino acid serine as a remedy for Alzheimer's disease. Because PHGDH is a key enzyme in the production of serine, the increased PHGDH expression found in Alzheimer's patients suggests that the rate of serine production in the brain is also increased, and thus, taking additional serine may not be beneficial, the researchers warned.

Researchers led by Sheng Zhong, a professor of bioengineering at the UC San Diego Jacobs School of Engineering, and Xu Chen, a professor of neurosciences at UC San Diego School of Medicine, published their findings May 3 in Cell Metabolism.

The new study builds on earlier work by Zhong and colleagues that first identified PHGDH as a potential blood biomarker for Alzheimer's disease. The researchers had analyzed blood samples of older adults and found a steep increase in PHGDH gene expression in Alzheimer's patients, as well as in healthy individuals approximately two years before they were diagnosed with the disease.

The results were promising, and the researchers were curious if this increase could be linked back to the brain. In their new study, they show that this indeed is the case.

"It's exciting that our previous discovery of a blood biomarker is now corroborated with brain data," said Zhong. "Now we have strong evidence that the changes we see in human blood are directly correlated to changes in the brain in Alzheimer's disease."

The researchers analyzed genetic data collected from post-mortem human brains from subjects in four different research cohorts, each made up of 40 to 50 individuals 50 years and older. The subjects consisted of Alzheimer's patients, so-called "asymptomatic" individuals (people without cognitive problems and without an Alzheimer's diagnosis, but whose post-mortem brain analyses showed early signs of Alzheimer's-related changes), and healthy controls.

The results showed a consistent increase in PHGDH expression among Alzheimer's patients and asymptomatic individuals in all four cohorts compared to the healthy controls. Moreover, expression levels were higher the more advanced the disease. This trend was also observed in two different mouse models of Alzheimer's disease.

The researchers also compared the subjects' PHGDH expression levels with their scores on two different clinical assessments: the Dementia

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Rating Scale, which rates a person's memory and cognitive ability, and Braak staging, which rates the severity of Alzheimer's disease based on the brain's pathology. The results showed that the worse the scores, the higher the expression of PHGDH in the brain.

"The fact that this gene's expression level directly correlates with both a person's cognitive ability and disease pathology is remarkable," said Zhong. "Being able to quantify both of these complex metrics with a single molecular measurement could potentially make diagnosis and monitoring progression of Alzheimer's disease much simpler."

The case against serine

The findings come with implications for serine supplements, which are advertised to improve memory and cognitive function. The key player responsible for making serine in the body is PHGDH. Some researchers have proposed that PHGDH expression is reduced in Alzheimer's disease, and that boosting serine intake could help with treatment and prevention. Clinical trials are already underway to test serine treatments in older adults experiencing cognitive decline.

But with their data consistently showing increased PHGDH expression in Alzheimer's, the researchers posit that serine production may likely be increased in this disease, contrary to what some other groups claim.

"Anyone looking to recommend or take serine to mitigate Alzheimer's symptoms should exercise caution," said co-first author Riccardo Calandrelli, who is a research associate in Zhong's lab.

Next steps

The researchers are looking to study how changing PHGDH gene expression will affect disease outcomes. The approach could lead to new therapeutics for Alzheimer's.

A San Diego-based biotechnology startup co-founded by Zhong, called Genemo, is working to develop a PHGDH blood test for early detection of Alzheimer's disease.

Medical Xpress, 3 May 2022

https://medicalxpress.com

Rapid adaptation of deep learning teaches drones to survive any weather

2022-05-05

To be truly useful, drones -- that is, autonomous flying vehicles -- will need to learn to navigate real-world weather and wind conditions.

Right now, drones are either flown under controlled conditions, with no wind, or are operated by humans using remote controls. Drones have been taught to fly in formation in the open skies, but those flights are usually conducted under ideal conditions and circumstances.

However, for drones to autonomously perform necessary but quotidian tasks, such as delivering packages or airlifting injured drivers from a traffic accident, drones must be able to adapt to wind conditions in real time -- rolling with the punches, meteorologically speaking.

To face this challenge, a team of engineers from Caltech has developed Neural-Fly, a deep-learning method that can help drones cope with new and unknown wind conditions in real time just by updating a few key parameters.

Neural-Fly is described in a study published on May 4 in Science Robotics. The corresponding author is Soon-Jo Chung, Bren Professor of Aerospace and Control and Dynamical Systems and Jet Propulsion Laboratory Research Scientist. Caltech graduate students Michael O'Connell (MS '18) and Guanya Shi are the co-first authors.

Neural-Fly was tested at Caltech's Center for Autonomous Systems and Technologies (CAST) using its Real Weather Wind Tunnel, a custom 10-foot-by-10-foot array of more than 1,200 tiny computer-controlled fans that allows engineers to simulate everything from a light gust to a gale.

"The issue is that the direct and specific effect of various wind conditions on aircraft dynamics, performance, and stability cannot be accurately characterized as a simple mathematical model," Chung says. "Rather than try to qualify and quantify each and every effect of turbulent and unpredictable wind conditions we often experience in air travel, we instead employ a combined approach of deep learning and adaptive control that allows the aircraft to learn from previous experiences and adapt to new conditions on the fly with stability and robustness guarantees."

O'Connell adds: "We have many different models derived from fluid mechanics, but achieving the right model fidelity and tuning that model

Drones must be able to adapt to wind conditions in real time -- rolling with the punches, meteorologically speaking.

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for each vehicle, wind condition, and operating mode is challenging. On the other hand, existing machine learning methods require huge amounts of data to train yet do not match state-of-the-art flight performance achieved using classical physics-based methods. Moreover, adapting an entire deep neural network in real time is a huge, if not currently impossible task."

Neural-Fly, the researchers say, gets around these challenges by using a so-called separation strategy, through which only a few parameters of the neural network must be updated in real time.

"This is achieved with our new meta-learning algorithm, which pre-trains the neural network so that only these key parameters need to be updated to effectively capture the changing environment," Shi says.

After obtaining as little as 12 minutes of flying data, autonomous quadrotor drones equipped with Neural-Fly learn how to respond to strong winds so well that their performance significantly improved (as measured by their ability to precisely follow a flight path). The error rate following that flight path is around 2.5 times to 4 times smaller compared to the current state of the art drones equipped with similar adaptive control algorithms that identify and respond to aerodynamic effects but without deep neural networks.

Neural-Fly, which was developed in collaboration with Caltech's Yisong Yue, Professor of Computing and Mathematical Sciences, and Anima Anandkumar, Bren Professor of Computing and Mathematical Sciences, is based on earlier systems known as Neural-Lander and Neural-Swarm. Neural-Lander also used a deep-learning method to track the position and speed of the drone as it landed and modify its landing trajectory and rotor speed to compensate for the rotors' backwash from the ground and achieve the smoothest possible landing; Neural-Swarm taught drones to fly autonomously in close proximity to each other.

Though landing might seem more complex than flying, Neural-Fly, unlike the earlier systems, can learn in real time. As such, it can respond to changes in wind on the fly, and it does not require tweaking after the fact. Neural-Fly performed as well in flight tests conducted outside the CAST facility as it did in the wind tunnel. Further, the team has shown that flight data gathered by an individual drone can be transferred to another drone, building a pool of knowledge for autonomous vehicles.

At the CAST Real Weather Wind Tunnel, test drones were tasked with flying in a pre-described figure-eight pattern while they were blasted

with winds up to 12.1 meters per second -- roughly 27 miles per hour, or a six on the Beaufort scale of wind speeds. This is classified as a "strong breeze" in which it would be difficult to use an umbrella. It ranks just below a "moderate gale," in which it would be difficult to move and whole trees would be swaying. This wind speed is twice as fast as the speeds encountered by the drone during neural network training, which suggests Neural-Fly could extrapolate and generalize well to unseen and harsher weather.

The drones were equipped with a standard, off-the-shelf flight control computer that is commonly used by the drone research and hobbyist community. Neural-Fly was implemented in an onboard Raspberry Pi 4 computer that is the size of a credit card and retails for around $20.

Science Daily, 5 May 2022

https://sciencedaily.com

Higher antioxidant levels linked to lower dementia risk

2022-05-04

People with higher levels of antioxidants in their blood may be less likely to develop dementia, according to a study published in the May 4, 2022, online issue of Neurology®, the medical journal of the American Academy of Neurology.

The study found that people with the highest levels of the antioxidants lutein and zeaxanthin and beta-cryptoxanthin in their blood were less likely to develop dementia decades later than people with lower levels of the antioxidants. Lutein and zeaxanthin are found in green, leafy vegetables such as kale, spinach, broccoli and peas. Beta-cryptoxanthin is found in fruits such as oranges, papaya, tangerines and persimmons.

"Extending people's cognitive functioning is an important public health challenge," said study author May A. Beydoun, PhD, MPH, of the National Institutes of Health's National Institute on Aging in Baltimore, Maryland. "Antioxidants may help protect the brain from oxidative stress, which can cause cell damage. Further studies are needed to test whether adding these antioxidants can help protect the brain from dementia."

The study involved 7,283 people who were at least 45 years old at the beginning of the study. They had a physical exam, interview and blood tests for antioxidant levels at the beginning of the study. They were then followed for an average of 16 years to see who developed dementia.

Lutein and zeaxanthin are found in green, leafy vegetables such as kale, spinach, broccoli and peas. Beta-cryptoxanthin is found in fruits such as oranges, papaya, tangerines and persimmons.

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The participants were divided into three groups based on their levels of antioxidants in the blood. People with the highest amounts of lutein and zeaxanthin were less likely to develop dementia than those with lower levels. Every standard deviation increase in lutein and zeaxanthin levels, approximately 15.4 micromols/liter, was associated with a 7% decrease in risk of dementia. For beta-cryptoxanthin, every standard deviation increase in levels, approximately 8.6 micromols/liter, was associated with a 14% reduced risk of dementia.

"It's important to note that the effect of these antioxidants on the risk of dementia was reduced somewhat when we took into account other factors such as education, income and physical activity, so it's possible that those factors may help explain the relationship between antioxidant levels and dementia," Beydoun said.

A limitation of the study is that antioxidant levels were based on one measurement of blood levels and may not reflect people's levels over their lifetime.

The study was supported by the National Institute on Aging, part of the National Institutes of Health.

Science Daily, 4 May 2022

https://sciencedaily.com

Why some beaches, including in Queensland, are getting bigger despite rising sea levels

2022-05-01

In a warmer world, rising sea levels could render many coastlines, beaches, and reef islands uninhabitable, or destroy them altogether. The 1.09 °C Earth has warmed since pre-industrial times has already heightened seas by 20 centimetres.

But curiously, research shows some coastlines and even low-lying coral reef islands are actually growing rather than eroding in the face of rising sea levels. This is happening on some beaches in Queensland and New South Wales, along with coastlines in Asia and Africa.

This goes against the general understanding of how climate change impacts the coast and has led to confusion that has been, in part, deliberately sown into public discourse by climate change deniers. So what's going on?

To examine the phenomenon, we investigated coastal changes using historical aerial photographs and satellite records. We found the observed growth of coastlines is largely linked to the "coastal sediment budget" – the amount of sand, rocks and other sediment moving into and out of the beach over time.

Our results show just how dynamic and complex the coast is, highlighting a need for greater understanding of local coastal changes, even down to individual beaches, when making coastal management plans.

Understanding sediment budgets

To make sense of this phenomenon, we first need to understand sediment budgets. A "positive" sediment budget is when more sand comes to the beach than leaves. A "negative" budget the opposite, when more sand leaves than arrives.

Over time a positive sediment budget drives growth on the coast – and beaches expand further into the ocean.

Sea level rise, on the other hand, erodes sand from the beach and places it elsewhere on the coast. This can lead to a loss of sand from the beach – and the shoreline retreats inland.

Read more: From enormous tides to millions of shells, here are 6 unique beaches for your summer road trip

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So if sea levels are rising across the planet, why are some beaches still getting bigger?

The answer is that for growing beaches, the positive sediment budget currently has a greater impact than erosion from sea level rise. In other words, the amount of sand coming to the coast is greater than the amount lost to sea level rise.

Beaches in Queensland

We investigated change on the coast of Queensland at 15 beaches stretching from north of Cooktown to Coolangatta, using the aerial photograph record from the 1930's to present. We also investigated shoreline change globally using the satellite record since 1984.

Despite global sea levels rising 20 centimetres over this time, every beach we investigated in Queensland was growing.

When we looked at coastal changes on at a global scale, we found large parts of entire continents, such as Africa and Southeast Asia, were also growing. This suggests that net positive sediment budgets on the coast are common.

It may be explained by two things. In natural settings, extra sand likely arrives from either deeper sediment located on the continental shelf or from rivers. Human intervention, in the form of coastal development, also drives coastal growth.

In Queensland, for example, Bucasia Beach has grown due to the natural input of sediment over time, likely from a nearby river. Meanwhile, Coolangatta Beach in the Gold Coast has grown due to human intervention that placed additional sand on the beach to mitigate and reverse trends of erosion.

At a global scale, parts of China's coast have grown due to human development on the coast. Other regions, such as Suriname, South America, have grown due to large or fast rivers transporting enormous quantities of sediment to the coast.

These results show that sediment budgets and human intervention can be much greater drivers of coastal change than a relatively small rise in sea level.

However, this doesn't mean sea level rise driven erosion isn't a real risk in the future. Instead, we should ask: what happens when, as forecasted, the rate of sea level rise continues to accelerate?

What does this mean for the future?

The Intergovernmental Panel on Climate Change (IPCC) forecasts sea levels to reach up to 1.01 metres higher (relative to the 1995-2014 level) by 2100 if global emissions continue unabated.

What's more, sea level rise is getting faster. The IPCC found it rose 1.3 millimetres per year during 1901-1971, 1.9mm per year during 1971-2006, and 3.7mm per year during 2006-2018.

This increase in sea level may drive a loss of sediment to the beach that current positive sediment budgets can no longer offset. This could trigger erosion in beaches presently growing.

So it's important coastlines presently growing aren't seen as evidence that sea level rise does not drive coastal erosion. Nor that such coasts are free from future erosion risk.

Even if there's enough sediment to maintain growth on the coast, hazardous erosion and inundation due to storms and cyclones can still occur.

When we seek to understand and mitigate the future impact of sea level rise on the coast we should also ask: when does coastal erosion become hazardous?

Coastal erosion is, by itself, a natural process and is only a problem when human infrastructure or livelihoods are at risk.

The sediment budget and decisions we make on the coast – where we build, where we intervene, and where we don't – are just as critical as sea level rise in the future.

Most of Australia's coast is undeveloped and the positive sediment budget on many beaches will limit future erosion.

If we continue to leave them alone, the risk of future hazardous erosion under climate change is low. If, however, we place people and infrastructure too close to the shoreline and disrupt coastal sediment budgets, we will increase our future climate risk.

The Conversation, 1 May 2022

https://theconversation.com

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Explaining how Ritalin sharpens attention

2022-04-29

Even half a century after a drug comes on the market, scientists can still learn new things about how it works. New research from University of Pittsburgh neuroscientists provides a rare look at how Ritalin affects activity in the brains of animals, providing a deeper understanding of how groups of brain cells govern attention and pointing to new possible uses for the stimulant.

Around 1 in 11 children in the U.S. are prescribed stimulants like methylphenidate (also known by its brand name Ritalin) to improve attention and focus in people with attention-deficit/hyperactivity disorder, or ADHD. Many more adults, an estimated 1 in 5 according to surveys, also use the drugs off-label. And while the safety and efficacy of these drugs is well understood, there's still plenty left to learn about how they work.

Around 1 in 11 children in the U.S. are prescribed stimulants like methylphenidate (also known by its brand name Ritalin) to improve attention and focus in people with attention-deficit/hyperactivity disorder, or ADHD.

"We really know very little about what these drugs do to the activity of groups of neurons," said senior study author Marlene Cohen, a professor of neuroscience in the Kenneth P. Dietrich School of Arts and Sciences. "But basic scientists like us have been investigating what groups of neurons can tell us about behavior and cognition, and so understanding what these drugs do to groups of neurons can maybe give us hints about other things that they would be useful for."

Previous work led by Pitt postdoctoral researcher Amy Ni showed a link between how well animals did on a visual task and a particular measurement of neurons in the visual cortex—specifically, how likely they are to fire off independent of one another, as opposed to being synched up.

In the current work, they found that animals that had taken methylphenidate performed better on a visual task of attention, and that the improvement happened exactly when that same metric of neuron activity shifted. The team, led by Ni, published their research in the journal Proceedings of the National Academy of Sciences on April 25.

Some of the study results were expected from what's already known about the drug. The three animals took methylphenidate or a placebo on alternating days for two weeks of tests. On days when they took the drug, they spent longer on the task and performed better at it, but only when the required task occurred in a spot they were already paying attention to.

In most neuroscience experiments, researchers target very small groups of neurons with electricity or light. "We definitely didn't do that—we took these drugs, mixed them in fruit juice and gave them to the animals," Cohen said. "It surprised me that a very general manipulation would have a very specific behavioral effect."

Along with learning more about how the drug works, such experiments allow researchers to gain a broader understanding of how patterns of firing neurons translate into behaviors like paying attention to what we see. By comparing how neurons act when the brain is in different states—such as when a subject has taken a drug versus when they haven't—researchers can create more complete and useful models of how brain cells and behavior are linked.

It's an approach that hasn't received much attention, Cohen said, due in part to a lack of ways to fund research on how drugs change the activity of neurons. That makes it difficult to look for "crossover treatments," i.e., novel uses for drugs that are already on the market.

In light of the current study, previous work in the lab hints at some of these potential crossovers. Research by Ni has found similarities between neural patterns linked to attention and certain kinds of learning, suggesting that treatments for disorders involving one might be effective for the other.

"These stimulants might actually be useful for treating a lot of things, ranging from the cognitive changes associated with normal aging, to Alzheimer's disease and others," Cohen said. Though it's currently just a well-informed hunch, it's one the lab plans to pursue in future studies.

For now, this study remains an important first step in a line of research Cohen hopes to see far more of: connecting the dots between the neural underpinnings of our behavior and how drugs affect it.

"It's one test case, and I think there's a lot more to be done," she said. "I hope that people will see that these approaches are important."

Medical Xpress, 29 April 2022

https://medicalxpress.com

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Could Organic Polymer Batteries Save Us From Lithium?

2022-05-02

Researchers at Flinders University have made huge steps towards the production of an "organic" polymer battery by doubling its energy storage capacity.

The batteries that we use today in most of our electronics are made up of rare earth elements – cobalt and lithium, in particular. The materials are, as you can guess, rare and we need to mine to get them. While there are many efforts to get more use out of lithium-ion batteries, there are also efforts to look at alternatives.

That's where a concept like an organic polymer battery comes in, which could theoretically be a more environmentally friendly type of energy storage that uses polymers made from organic compounds.

Together with Chinese collaborators, researchers from Flinders University have created two-electron storage in "organic radical batteries" by using a catalysis strategy, effectively doubling the capacity of what was previously considered to be the high point of energy storage in the battery type.

"Catalysis has been widely used in lithium-based batteries such as lithium-oxygen batteries and lithium-sulphur batteries to improve their energy and power performance," says Doctor Zhongfan Jia, a senior lecturer in chemistry at the Flinders University Institute for Nanoscale Science and Technology.

The aim of the research is to one day cut down on toxic waste in landfill, which is where many lithium-ion batteries end up if not disposed of correctly (reminder: please dispose of your phone correctly). One day, the technology could lead to a reduced reliance on lithium and cobalt mining, if polymer batteries begin to be used commonly.

Up until now, the uptake of polymer batteries has been prevented by their storage limitations, however, this could be coming to an end with research like this. While previous research indicated that only one electron could be reversibly stored in materials (providing a maximum capacity of 110 mAh/g), this development doubles this electron amount, bumping storage up quite a bit. This comes after research into the voltage of organic batteries.

"This battery can deliver a capacity of 175 mAh/g, which is comparable to the commercialised lithium-ion battery, making a step closer to the practical use of ORBs," added Jia.

The aim of the research is to one day cut down on toxic waste in landfill, which is where many lithium-ion batteries end up if not disposed of correctly.

"Our next goal is to combine these advances to develop organic batteries that can be implemented in consumer electronics."

Applications for the technology include small electronics like smartphones, however, development is still underway.

Perhaps one day, in a truly idyllic, sustainable world, we'll be able to power our electronics without having to rely on massive amounts of lithium and cobalt.

You can read all about the polymer battery research from Flinders University in ACS Energy Letters.

Gizmodo, 2 May 2022

https://gizmodo.com.au

A new wearable technology—for plants

2022-05-04

Plants can't speak up when they are thirsty. And visual signs, such as shriveling or browning leaves, don't start until most of their water is gone. To detect water loss earlier, researchers reporting in ACS Applied Materials & Interfaces have created a wearable sensor for plant leaves. The system wirelessly transmits data to a smartphone app, allowing for remote management of drought stress in gardens and crops.

Newer wearable devices are more than simple step-counters. Some smart watches now monitor the electrical activity of the wearer's heart with electrodes that sit against the skin. And because many devices can wirelessly share the data that are collected, physicians can monitor and assess their patients' health from a distance.

Similarly, plant-wearable devices could help farmers and gardeners remotely monitor their plants' health, including leaf water content—the key marker of metabolism and drought stress. Previously, researchers had developed metal electrodes for this purpose, but the electrodes had problems staying attached, which reduced the accuracy of the data. So, Renato Lima and colleagues wanted to identify an electrode design that was reliable for long-term monitoring of plants' water stress, while also staying put.

The researchers created two types of electrodes: one made of nickel deposited in a narrow, squiggly pattern, and the other cut from partially burnt paper that was coated with a waxy film. When the team affixed

The system wirelessly transmits data to a smartphone app, allowing for remote management of drought stress in gardens and crops.

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both electrodes to detached soybean leaves with clear adhesive tape, the nickel-based electrodes performed better, producing larger signals as the leaves dried out.

The metal ones also adhered more strongly in the wind, which was likely because the thin squiggly design of the metallic film allowed more of the tape to connect with the leaf surface. Next, the researchers created a plant-wearable device with the metal electrodes and attached it to a living plant in a greenhouse.

The device wirelessly shared data to a smartphone app and website, and a simple, fast machine learning technique successfully converted these data to the percent of water content lost. The researchers say that monitoring water content on leaves can indirectly provide information on exposure to pests and toxic agents.

Because the plant-wearable device provides reliable data indoors, they now plan to test the devices in outdoor gardens and crops to determine when plants need to be watered, potentially saving resources and increasing yields.

Tech Xplore, 4 May 2022

https://techxplore.com

Self-propelled, endlessly programmable artificial cilia

2022-05-06

For years, scientists have been attempting to engineer tiny, artificial cilia for miniature robotic systems that can perform complex motions, including bending, twisting, and reversing. Building these smaller-than-a-human-hair microstructures typically requires multi-step fabrication processes and varying stimuli to create the complex movements, limiting their wide-scale applications.

Now, researchers from the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) have developed a single-material, single-stimuli microstructure that can outmaneuver even living cilia. These programmable, micron-scale structures could be used for a range of applications, including soft robotics, biocompatible medical devices, and even dynamic information encryption.

The research is published in Nature.

These programmable, micron-scale structures could be used for a range of applications, including soft robotics, biocompatible medical devices, and even dynamic information encryption.

"Innovations in adaptive self-regulated materials that are capable of a diverse set of programmed motions represent a very active field, which is being tackled by interdisciplinary teams of scientists and engineers," said Joanna Aizenberg, the Amy Smith Berylson Professor of Materials Science and Professor of Chemistry & Chemical Biology at SEAS and senior author of the paper. "Advances achieved in this field may significantly impact the ways we design materials and devices for a variety of applications, including robotics, medicine and information technologies."

Unlike previous research, which relied mostly on complex multi-component materials to achieve programmable movement of reconfigurable structural elements, Aizenberg and her team designed a microstructure pillar made of a single material—a photoresponsive liquid crystal elastomer. Because of the way the fundamental building blocks of the liquid crystal elastomer are aligned, when light hits the microstructure, those building blocks realign and the structure changes shape.

As this shape change occurs, two things happen. First, the spot where the light hits becomes transparent, allowing the light to penetrate further into the material, causing additional deformations. Second, as the material deforms and the shape moves, a new spot on the pillar is exposed to light, causing that area to also change shape.

This feedback loop propels the microstructure into a stroke-like cycle of motion.

"This internal and external feedback loop gives us a self-regulating material. Once you turn the light on, it does all its own work," said Shucong Li, a graduate student in the Department of Chemistry and Chemical Biology at Harvard and co-first author of the paper.

When the light turns off, the material snaps back to its original shape.

The material's specific twists and motions change with its shape, making these simple structures endlessly reconfigurable and tunable. Using a model and experiments, the researchers demonstrated the movements of round, square, L- and T-shaped, and palm-tree-shaped structures and laid out all the other ways the material can be tuned.

"We showed that we can program the choreography of this dynamic dance by tailoring a range of parameters, including illumination angle, light intensity, molecular alignment, microstructure geometry, temperature, and irradiation intervals and duration," said Michael M. Lerch, a postdoctoral fellow in the Aizenberg Lab and co-first author of the paper.

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To add another layer of complexity and functionality, the research team also demonstrated how these pillars interact with each other as part of an array.

"When these pillars are grouped together, they interact in very complex ways because each deforming pillar casts a shadow on its neighbor, which changes throughout the deformation process," said Li. "Programming how these shadow-mediated self-exposures change and interact dynamically with each other could be useful for such applications as dynamic information encryption."

"The vast design space for individual and collective motions is potentially transformative for soft robotics, micro-walkers, sensors, and robust information encryption systems," said Aizenberg.

Phys Org, 6 May 2022

https://phys.org

Honeybees join humans as the only known animals that can tell the difference between odd and even numbers

2022-04-29

"Two, four, six, eight; bog in, don't wait."

As children, we learn numbers can either be even or odd. And there are many ways to categorize numbers as even or odd.

We may memorize the rule that numbers ending in 1, 3, 5, 7, or 9 are odd while numbers ending in 0, 2, 4, 6, or 8 are even. Or we may divide a number by 2—where any whole number outcome means the number is even, otherwise it must be odd.

Similarly, when dealing with real-world objects we can use pairing. If we have an unpaired element left over, that means the number of objects was odd.

Until now odd and even categorization, also called parity classification, had never been shown in non-human animals. In a new study, published today in the journal Frontiers in Ecology and Evolution, we show honeybees can learn to do this.

Why is parity categorization special?

Until now odd and even categorization, also called par-ity classification, had never been shown in non-human animals.

Parity tasks (such as odd and even categorization) are considered abstract and high-level numerical concepts in humans.

Interestingly, humans demonstrate accuracy, speed, language and spatial relationship biases when categorizing numbers as odd or even. For example, we tend to respond faster to even numbers with actions performed by our right hand, and to odd numbers with actions performed by our left hand.

We are also faster, and more accurate, when categorizing numbers as even compared to odd. And research has found children typically associate the word "even" with "right" and "odd" with "left."

These studies suggest humans may have learnt biases and/or innate biases regarding odd and even numbers, which may have arisen either through evolution, cultural transmission, or a combination of both.

It isn't obvious why parity might be important beyond its use in mathematics, so the origins of these biases remain unclear. Understanding if and how other animals can recognize (or can learn to recognize) odd and even numbers could tell us more about our own history with parity.

Training bees to learn odd and even

Studies have shown honeybees can learn to order quantities, perform simple addition and subtraction, match symbols with quantities and relate size and number concepts.

To teach bees a parity task, we separated individuals into two groups. One was trained to associate even numbers with sugar water and odd numbers with a bitter-tasting liquid (quinine). The other group was trained to associate odd numbers with sugar water, and even numbers with quinine.

We trained individual bees using comparisons of odd versus even numbers (with cards presenting 1–10 printed shapes) until they chose the correct answer with 80% accuracy.

Remarkably, the respective groups learnt at different rates. The bees trained to associate odd numbers with sugar water learned quicker. Their learning bias towards odd numbers was the opposite of humans, who categorize even numbers more quickly.

We then tested each bee on new numbers not shown during the training. Impressively, they categorized the new numbers of 11 or 12 elements as odd or even with an accuracy of about 70%.

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Our results showed the miniature brains of honeybees were able to understand the concepts of odd and even. So a large and complex human brain consisting of 86 billion neurons, and a miniature insect brain with about 960,000 neurons, could both categorize numbers by parity.

Does this mean the parity task was less complex than we'd previously thought? To find the answer, we turned to bio-inspired technology.

Creating a simple artificial neural network

Artificial neural networks were one of the first learning algorithms developed for machine learning. Inspired by biological neurons, these networks are scalable and can tackle complex recognition and classification tasks using propositional logic.

We constructed a simple artificial neural network with just five neurons to perform a parity test. We gave the network signals between 0 and 40 pulses, which it classified as either odd or even. Despite its simplicity, the neural network correctly categorized the pulse numbers as odd or even with 100% accuracy.

This showed us that in principle parity categorization does not require a large and complex brain such as a human's. However, this doesn't necessarily mean the bees and the simple neural network used the same mechanism to solve the task.

Simple or complex?

We don't yet know how the bees were able to perform the parity task. Explanations may include simple or complex processes. For example, the bees may have:

1. paired elements to find an unpaired element
2. performed division calculations—although division has not been previously demonstrated by bees
3. counted each element and then applied the odd/even categorization rule to the total quantity.

By teaching other animal species to discriminate between odd and even numbers, and perform other abstract mathematics, we can learn more about how math and abstract thought emerged in humans.

Is discovering math an inevitable consequence of intelligence? Or is math somehow linked to the human brain? Are the differences between

humans and other animals less than we previously thought? Perhaps we can glean these intellectual insights, if only we listen properly.

Phys Org, 29 April 2022

https://phys.org

The device hoping to answer the ultimate existential questions

2022-05-02

The final piece of an all-new detector has completed the first leg of its journey towards unlocking some of the most enduring mysteries of the universe.

The 41-million-pixel Vertex Locator (VELO) was assembled at the University of Liverpool. It was assembled from components made at different institutes, before it traveled to its home at the Large Hadron Collider beauty (LHCb) experiment at CERN.

Once installed in time for data-taking, it will attempt to answer the following questions:

- Why is the universe made of matter, not antimatter?
- Why does it exist at all?
- What else is out there?

A fine balance at the dawn of space and time

In the moments immediately after the Big Bang, the universe was caught in a fine balance between matter and antimatter.

From what we understand about the laws of nature, these forms of matter should have annihilated each other and left behind a universe filled only with light. Yet, against all odds, matter somehow gained the advantage and something was left to form the universe we know today.

Our best understanding of the physics of the Big Bang tells us that matter and antimatter were created in equal quantities. When they made contact in the (far smaller and far denser) early universe, all of their combined mass should have been violently transformed into pure energy. Why, and how, matter survived the encounter is one of the most profound mysteries in modern science.

The current theory is that, although matter and antimatter were created as almost perfect mirror images, there must have been some tiny misbalance,

From what we understand about the laws of nature, [antimatter and] matter should have annihilated each other and left behind a universe filled only with light.

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or blemish. This meant that some were not perfect reflections. This difference, however tiny, might have been enough to give matter the edge.

Through the looking glass

Scientists have already found a small crack in the mirror, called charge-parity (CP) violation. This means that, in some cases, the symmetry of the matter and antimatter reflection becomes broken.

This results in a particle that is not the perfect opposite of its twin, and this "broken symmetry" may mean that one particle could have an advantage over the other.

When this symmetry is broken, an antimatter particle may decay at a different rate to its matter counterpart. If enough of these violations occurred after the Big Bang, it might explain why matter survived.

By behaving differently to their antimatter equivalents, it is possible that matter particles with broken symmetry took just a little bit longer to decay. If this caused matter to stick around just a little bit longer, it could explain how it was the last one standing.

The deep unknown

Why matter survived is not the only mystery in the universe. There is another issue puzzling scientists: what might dark matter be?

Dark matter is an elusive, invisible type of matter that supplies the gravitational glue to keep stars moving around galaxies. Because we do not yet know what dark matter is, it could be that there are other, new particles and forces in the universe that we have not yet seen.

Discovering anything new could reveal a radically different picture of nature to the one we have. New particles like these could announce themselves by subtly changing the way the particles we can see behave, leaving small but detectable traces in our data.

The beauty and charm of VELO

The new VELO detector, which will replace the old VELO detector, will be used to investigate the subtle differences between matter and antimatter versions of particles that contain subatomic particles. These are known as beauty quarks and charm quarks.

These exotic quark-containing particles, also known as B and D mesons, are produced during collisions within the Large Hadron Collider (LHC). They are difficult to study because mesons are very unstable and decay out of existence within a fraction of a fraction of a second.

When they decay, however, they actually transform into something else. Scientists believe that, by studying these different decays and their properties, VELO data will help LHCb to reveal the fundamental forces and symmetries of nature.

Incredibly precise measurements

The new VELO detector will sit as close as possible to where the particles collide within the LHCb experiment. These particles decay in less than a millionth of a millionth of a second and travel only a few millimeters. Therefore, this close proximity will give the device the best possible chance of measuring their properties.

VELO's sensitivity and proximity to the LHC's beams will allow it to take incredibly precise measurements of the particles as they decay.

By comparing these readings to predictions made by the Standard Model (the guiding theory of particle physics) scientists can look for deviations that might hint at new particles in nature. They can also look for CP violations or other reasons why matter and antimatter behave differently.

These deviations could revolutionize our understanding of why the universe is what it is.

Building on the legacy of the old

The VELO may be brand new and cutting-edge but it will be building on the legacy of the previous VELO detector. The VELO has a state-of-the-art pixel detector made up of grids of tiny squares of silicon that gives high-resolution even in the challenging radiation environment near the LHC beams.

Its predecessor, with its lines of stacked silicon detectors, helped the LHCb make discoveries, including:

- New states of matter.
- Incredibly rare beauty quark decays.
- Differences between matter and antimatter charm quarks.
- The first intriguing indication of as yet unexplained behavior in beauty quark decay.

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Glimpses of particle behavior

UK VELO project leader Professor Themis Bowcock, from the University of Liverpool, said: "The data captured by the old VELO detector has given us really tantalizing glimpses of particle behavior. To make progress, we need to turn this into a really thorough, forensic investigation and this is where the new VELO detector comes in. It gives us the precise set of eyes we need to observe particles at the level of detail we need. Quite simply, the VELO makes our whole physics program possible on LHCb."

Unprecedented detail

New VELO will be able to capture these decays in unprecedented detail.

Couple this with upgraded software and super-fast readout electronics that will allow beauty and charm quarks to be pinpointed in real-time. Scientists will have a device that allows them to track and analyze decays that were previously too difficult to reconstruct.

What also makes the new VELO detector unique is that scientists can lift it out of the way as they prepare the particle beams for collisions. Then, they can move it mechanically into place when LHCb is ready to collect data.

This allows scientists to capture clear information from the first particles that radiate from the collisions without unnecessary wear and tear from the beam.

Phys Org, 2 May 2022

https://phys.org

Taste of the future: Robot chef learns to 'taste' as it goes

2022-05-04

A robot "chef" has been trained to taste food at different stages of the chewing process to assess whether it's sufficiently seasoned.

Working in collaboration with domestic appliances manufacturer Beko, researchers from the University of Cambridge trained their robot chef to assess the saltiness of a dish at different stages of the chewing process, imitating a similar process in humans.

Their results could be useful in the development of automated or semi-automated food preparation by helping robots to learn what tastes good and what doesn't, making them better cooks.

The robot chef [...] tasted nine different variations of a simple dish of scrambled eggs and tomatoes at three different stages of the chewing process, and produced 'taste maps' of the different dishes.

When we chew our food, we notice a change in texture and taste. For example, biting into a fresh tomato at the height of summer will release juices, and as we chew, releasing both saliva and digestive enzymes, our perception of the tomato's flavor will change.

The robot chef, which has already been trained to make omelets based on human tasters' feedback, tasted nine different variations of a simple dish of scrambled eggs and tomatoes at three different stages of the chewing process, and produced "taste maps" of the different dishes.

The researchers found that this "taste as you go" approach significantly improved the robot's ability to quickly and accurately assess the saltiness of the dish over other electronic tasting technologies, which only test a single homogenized sample. The results are reported in the journal Frontiers in Robotics & AI.

The perception of taste is a complex process in humans that has evolved over millions of years: The appearance, smell, texture and temperature of food all affect how we perceive taste; the saliva produced during chewing helps carry chemical compounds in food to taste receptors mostly on the tongue; and the signals from taste receptors are passed to the brain. Once our brains are aware of the flavor, we decide whether we enjoy the food or not.

Taste is also highly individual: Some people love spicy food, while others have a sweet tooth. A good cook, whether amateur or professional, relies on their sense of taste, and can balance the various flavors within a dish to make a well-rounded final product.

"Most home cooks will be familiar with the concept of tasting as you go—checking a dish throughout the cooking process to check whether the balance of flavors is right," said Grzegorz Sochacki from Cambridge's Department of Engineering, the paper's first author. "If robots are to be used for certain aspects of food preparation, it's important that they are able to 'taste' what they're cooking."

"When we taste, the process of chewing also provides continuous feedback to our brains," said co-author Dr. Arsen Abdulali, also from the Department of Engineering. "Current methods of electronic testing only take a single snapshot from a homogenized sample, so we wanted to replicate a more realistic process of chewing and tasting in a robotic system, which should result in a tastier end product."

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The researchers are members of Cambridge's Bio-Inspired Robotics Laboratory run by Professor Fumiya Iida of the Department of Engineering, which focuses on training robots to carry out the so-called last-meter problems that humans find easy, but robots find difficult. Cooking is one of these tasks: Earlier tests with their robot "chef" have produced a passable omelet using feedback from human tasters.

"We needed something cheap, small and fast to add to our robot so it could do the tasting: It needed to be cheap enough to use in a kitchen, small enough for a robot, and fast enough to use while cooking," said Sochacki.

To imitate the human process of chewing and tasting in their robot chef, the researchers attached a conductance probe, which acts as a salinity sensor, to a robot arm. They prepared scrambled eggs and tomatoes, varying the number of tomatoes and the amount of salt in each dish.

Using the probe, the robot "tasted" the dishes in a grid-like fashion, returning a reading in just a few seconds.

To imitate the change in texture caused by chewing, the team then put the egg mixture in a blender and had the robot test the dish again. The different readings at different points of "chewing" produced taste maps of each dish.

Their results showed a significant improvement in the ability of robots to assess saltiness over other electronic tasting methods, which are often time-consuming and only provide a single reading.

While their technique is a proof of concept, the researchers say that by imitating the human processes of chewing and tasting, robots will eventually be able to produce food that humans will enjoy and could be tweaked according to individual tastes.

"When a robot is learning how to cook, like any other cook, it needs indications of how well it did," said Abdulali. "We want the robots to understand the concept of taste, which will make them better cooks. In our experiment, the robot can 'see' the difference in the food as it's chewed, which improves its ability to taste."

"Beko has a vision to bring robots to the home environment which are safe and easy to use," said Dr. Muhammad W. Chughtai, Senior Scientist at Beko plc. "We believe that the development of robotic chefs will play a major role in busy households and assisted living homes in the future. This result is a leap forward in robotic cooking, and by using machine and

deep learning algorithms, mastication will help robot chefs adjust taste for different dishes and users."

In future, the researchers are looking to improve the robot chef so it can taste different types of food and improve sensing capabilities so it can taste sweet or oily food, for example.

Tech Xplore, 4 May 2022

https://techxplore.com

As oceans warm will the methane 'Kraken' be released?

2022-05-04

A vast amount of the powerful greenhouse gas is sequestered as frozen crystals in the world's oceans. Of great concern among experts is the growing risk that, as the Earth warms and ocean temperatures rise, these highly disruptive, potent greenhouse gases will "flee" their frozen confinement.

To understand the stability of these crystalline hydrocarbon deposits, Ryan Hartman, associate professor of Chemical and Biomolecular Engineering at the NYU Tandon School of Engineering and Carolyn Koh of the Colorado School of Mines are launching an investigation into how this "fire ice" forms within a medium of sedimentary mineral deposits and remains in solid form under specific pressures and temperatures.

The work, "Kinetics of Gas Hydrate Crystallization and Dissociation in Tailored Confined Media" will focus on the structurally idiosyncratic formation of gas clathrate hydrates, the crystalline lattices of hydrogen-bonded water molecules that encapsulate small hydrocarbon (gas) molecules such as methane.

Specifically, the new study, which extends research conducted earlier this year on marine bio-symbiosis influenced by and influencing frozen hydrates, explores gas hydrate crystallization in nanopores—pores or cavities in a substance whose dimensions can be measured at the nanometer scale. In oceans worldwide, hydrate crystals form within the nanopores of sedimentary materials from the arctic permafrost to a range of deep marine environments.

The heterogeneous materials have profound implications for energy and climate change, particularly in deeper waters, where these structures dominate: while they are vital, energy-rich entities that form spontaneously from water and small hydrophobic molecules under

A vast amount of the powerful greenhouse gas is sequestered as frozen crystals in the world's oceans.

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specific temperature and pressure conditions, they also keep highly volatile greenhouse gases under frozen "lock and key."

He added that for gas hydrates within nanopores, this will be less of an issue. "This enhances their stability," he said. "For instance, crystallization in the nanopores can change the melting point temperature and composition of frozen hydrates, and also the speed at which the gas is released from them, by comparison to bulk crystallizations, not involving nanopores."

Hydrate formation is a nucleation and growth phenomenon; there is a critical crystal size beyond which thermodynamics favors growth over dissolution. While homogeneous nucleation of this critical size is possible in bulk water, it is known that heterogeneous nucleation—the formation of hydrate crystals within interstices of other mineral constituents—is a dominant process in natural and synthetic hydrates.

While the majority of hydrates have been found to crystallize in confined media (crystallization in confined spaces is an emerging area of inquiry), only a handful of investigations to date have studied the influence that porous materials have on hydrate crystallization.

The team aims to discover fundamental molecular-to-pore understanding of hydrate crystallization mechanisms in confinement, defined as crystallization constrained to: i) microscale gas-liquid or gas-liquid solid interfaces and ii) highly ordered, geometric nano- and micro-scale structured surfaces.

"We believe that the nature of the nanopores determines the gas hydrates nucleated in nanoconfinement, as well as their resultant molecular structure type and their crystallization and dissociation kinetics," said Hartman.

Hartman and Koh will use microfluidic systems, a key area of inquiry and expertise for Hartman, to design highly ordered nanoporous structures to hone in on why nanopore geometry controls the nucleated hydrate characteristics, as well as to understand why these characteristics influence the resultant hydrate kinetics. The team also aims to determine the role confinement has on crystal growth beyond the nanopore exits. They will use machine learning, incorporating data from pore-scale discoveries from advanced experimentation to build first-principle models and generate design rules.

"We think this work will have a profound impact on the broader scientific community by discovering the mechanisms of hierarchical crystallizations in confinement and, more generally, of materials that can trap small molecules," he added. "The research could also transform the way in which laboratory computations work in concert with advanced experimental methods for materials synthesis and manufacturing."

The work will couple creative physical experimental synthesis and processing techniques, artificial intelligence methods, and in situ real-time monitoring tools for the measurement of high fidelity, transient information on confined crystallization and dissociation.

Phys Org, 4 May 2022

https://phys.org

The multiverse is huge in pop culture right now – but what is it, and does it really exist?

2022-05-06

Whether you need a new villain or an old Spider-Man, your sci-fi movie will sound more scientifically respectable if you use the word multiverse. The Marvel multiverse puts different versions of our universe "out there", somewhere. In these films, with the right blend of technology, magic, and imagination, travel between these universes is possible.

For example (spoilers!), in Spider-Man: No Way Home, we discover there are other universes and other Earths, some of which have their own local Spider-Man. In the universe of the movie, magic is possible.

This magic, thanks to a misfiring spell from superhero Dr Strange, causes some of the other Spider-Men to be transported into our universe, along with a few supervillains.

In Doctor Strange in the Multiverse of Madness (in cinemas this week), the universe-on-universe buffoonery threatens a "desecration of reality".

So, which of these ideas has Marvel borrowed from science, and which ones are pure fiction?

Multiverse lite: a really big universe

Could there be other Earths? Could there be other people out there, who look a lot like us, on a planet that looks like ours? Scientifically, it's possible, because we don't know how big our universe actually is.

The Marvel multiverse might seem wild, but from a scientific perspective it's actually too tame. Too normal. Too familiar. Here's why.

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We can see billions of light years into space, but we don't know how much more space is out there, beyond what we can see.

If there is more space out there, full of galaxies, stars and planets, then there are more and more chances for Another-Earth to exist. Somewhere. With enough space and enough planets, any possibility becomes likely.

The fiction of the Marvel multiverse stems from the ability to travel between these other earths. There's a good reason why Dr Strange needs to use magic for this.

According to Albert Einstein, we can't travel through space faster than light. And while more exotic ways to travel around the universe are scientifically possible – wormholes, for example – we don't know how to make them, the universe doesn't seem to make them naturally, and there is no reason to think they'd connect us to Another-Earth rather than some random part of empty space.

So, almost certainly, if Another-Earth is out there somewhere, it's unimaginably far away, even for an astronomer.

Changing the laws of nature

The Marvel multiverse might seem wild, but from a scientific perspective it's actually too tame. Too normal. Too familiar. Here's why.

The basic building blocks of our universe - protons and neutrons (and their quarks), electrons, light, etc. - are able to make amazing things, such as human life. Your body is astounding: energy-gathering, information-processing, mini-machine building, self-repairing.

Physicists have discovered that the ability of our universe's building blocks to make life forms is extremely rare. Just any old blocks won't do.

If electrons had been too heavy, or the force that holds atomic nuclei together had been too weak, the stuff of the universe wouldn't even stick together, let alone make something as marvellous as a living cell. Or, indeed, anything that could be called alive.

How did our universe get the right mix of ingredients? Perhaps we won the cosmic lottery. Perhaps, on scales much bigger than what our telescopes can see, other parts of the universe have different building blocks.

Our universe is just one of the options – a particularly fortunate one – among a multiverse of universes with losing tickets.

This is the scientific multiverse: not simply more of our universe, but universes with different fundamental ingredients. Most are dead, but very very rarely, the right combination for life-forms comes up.

The Marvel multiverse, by contrast, merely rearranges the familiar atoms and forces of our universe (plus a bit of magic). That's not enough.

Cosmic inflation and the Big Bang

What was our universe like in the past? The evidence suggests that the universe was hotter, denser and smoother. This is called the Big Bang Theory.

But was there a Big Bang? Was there a moment when the universe was infinitely hot, infinitely dense, and contained in a single point? Well, maybe. But we're not sure, so scientists have explored a bunch of other options.

One idea, called cosmic inflation, says that in the first fraction of a second of the universe, it expanded extremely quickly. If true, it would explain a few things about why our universe expands in just the way it does.

But, how do you make a universe expand so rapidly? The answer is a new type of energy field. It has control of the first moments of the universe, causes a rapid expansion, and then hands the reins to the more familiar forms of matter and energy: protons, neutrons, electrons, light, etc.

Cosmic inflation might make a multiverse. Here's how. According this idea, most of space is expanding, inflating, doubling in size, moment to moment. Spontaneously and randomly, in small islands, the new energy field converts its energy into ordinary matter with enormously high energies, releasing what we now see as a Big Bang.

If these high energies scramble and reset the basic properties of matter, then each island can be thought of as a new universe with different properties. We've made a multiverse.

So is there a Multiverse?

In the cycle of the scientific method, the multiverse is in an exploratory phase. We've got an idea that might explain a few things, if it was true. That makes it worthy of our attention, but it's not quite science yet. We need to find evidence that is more direct, more decisive.

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Something left over from the aftermath of the multiverse generator might help. A multiverse idea could also predict the winning numbers on our lottery ticket.

However, as Dr Strange explains, "The multiverse is a concept about which we know frighteningly little."

The Conversation, 6 May 2022

https://theconversation.com

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Technical Notes

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(NOTE: OPEN YOUR WEB BROWSER AND CLICK ON HEADING TO LINK TO SECTION)

CHEMICAL EFFECTS

Non-target, suspect and target screening of chemicals of emerging concern in landfill leachates and groundwater in Guangzhou, South China

Observed and predicted embryotoxic and teratogenic effects of organic and inorganic environmental pollutants and their mixtures in zebrafish (Danio rerio)

ENVIRONMENTAL RESEARCH

Heavy metal pollution through hand loom-dyeing effluents and its effect on the community health

Wildfire, Smoke Exposure, Human Health, and Environmental Justice Need to be Integrated into Forest Restoration and Management

PHARMACEUTICAL/TOXICOLOGY

Poly- and perfluoroalkyl substances (PFAS) exposure through infant feeding in early life

Halogenated ingredients of household and personal care products as emerging endocrine disruptors

OCCUPATIONAL

Parental Occupational Exposure and Neurodevelopmental Disorders in Offspring: a Systematic Review and Meta-analysis

Evaluating risk, exposure, and detection capabilities for chemical threats in water

Occupational COPD-The most under-recognized occupational lung disease?

Occupational Benzene Exposure in the Norwegian Offshore Petroleum Industry, 2002-2018