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

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ASIA PACIFIC

New resources for storing pool chemicals

2019-11-22

Safe Work Australia has prepared a [new information sheet for storing swimming pool chemicals](#). This resource expands on the information in [Managing risks of storing chemicals in the workplace](#). The material was developed in consultation with representatives from work health and safety regulators, unions and industry groups. To find out more about complying with work health and safety requirements in your region, contact your [local WHS regulator](#)

Safe Work Australia, 20 November 2019

<http://www.safeworkaustralia.gov.au>

22 October 2019

A new digital regulatory system will boost efficiency and food safety standards in the Victorian dairy industry while helping to strengthen global competitiveness in the sector

2019-11-22

Minister for Agriculture Jaclyn Symes recently launched the *Dairy RegTech 2022* model at Dairy Food Safety Victoria's annual general meeting, with a \$500,000 investment from the Andrews Labor Government to pilot the program which reduces the regulatory burden for dairy licensees and supports dairy education initiatives. The pioneering model uses digital data collection and analytics to monitor the food safety performance of dairy businesses and has been designed in collaboration with the Victorian dairy industry to ensure global best practice in dairy regulation. Anyone involved in the production of dairy products in Victoria is required to have a licence and comply with specific conditions. For many licensees, this involves an audit process which focuses on reviewing paper records. The new digital model will support a proactive approach to meeting regulatory requirements and will include education and incentives to promote a positive food safety culture. Dairy Food Safety Victoria is currently working with manufacturers and will kick off the new model with the farming sector from next year. The dairy industry is worth \$1.9 billion to Victoria – as the country's largest dairy exporter, we produce 79 per cent of Australia's dairy exports. The Labor Government is committed

Safe Work Australia has prepared a new information sheet for storing swimming pool chemicals.

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to supporting Victoria's dairy industry, which is an important part of the state's \$14.1 billion agriculture sector and a key component of our plan to grow the sector to \$20 billion by 2030.

Premier of Victoria, 22 October 2019

<https://www.premier.vic.gov.au>

Work-related fatalities continue to decline

2019-11-22

Safe Work Australia has released the *Work-related Traumatic Injury Fatalities Australia 2018* report, which provides the latest detailed national statistics on all workers and bystanders fatally injured through work-related activity. The *Work-related Traumatic Injury Fatalities Australia 2018* report outlines the latest in national work-related traumatic injury fatality statistics.

The report shows that over the last decade, the fatality rate has more than halved with 1.1 worker fatalities per 100,000 workers in 2018.

The report details that 69 per cent of worker fatalities occurred in the following industries:

- Transport, postal and warehousing (38 fatalities)
- Agriculture, forestry and fishing (37 fatalities)
- Construction (24 fatalities)
- The most common causes of worker fatalities in 2018 were:
- Vehicle collisions (44 fatalities)
- Being hit by a moving object (24 fatalities)
- Falls from a height (18 fatalities)

The report and data are drawn from a range of sources, including initial reporting of fatalities in the media, notifications from jurisdictional authorities, and the National Coronial Information System. You can download a PDF of the report or view it on the [Safe Work Australia website](#).

Safe Work Australia, 18 November 2019

<http://www.safeworkaustralia.gov.au>

Safe Work Australia has released the *Work-related Traumatic Injury Fatalities Australia 2018* report, which provides the latest detailed national statistics on all workers and bystanders fatally injured through work-related activity.

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APVMA MRL Standard maintenance

2019-11-22

The Australian Pesticides and Veterinary Medicine Authority (APVMA) has undertaken some maintenance on the APVMA MRL Standard to standardise formatting and the expression of commodity names in Tables 1 and 4. This has resulted in many small changes of no regulatory consequence. As a result, APVMA have remade the Standard and it is now known as the *Agricultural and Veterinary Chemicals Code (MRL Standard) Instrument 2019*. The *Agricultural and Veterinary Chemicals Code Instrument No. 4 (MRL Standard) 2012* was repealed on 28 August 2019.

APVMA Regulatory Update, 14 November 2019

<http://www.apvma.gov.au>

Philippine DENR Issues Order for Polymer and PLC Exemption from PMPIN

2019-11-22

On 8 November 2019, the Philippine Department of Environment and Natural Resources (DENR) issued the *Administrative Order for Polymers and Polymer of Low Concern Exemption from the PMPIN Process*, aiming to grant Pre-Manufacture and Pre-Importation Notification (PMPIN) exemption to importers and manufacturers of polymers and polymers of low concern (PLCs). Specifically, to be exempt from the PMPIN requirements, polymers should satisfy any of the following requirements:

- All of its monomers should be listed in the PICCS;
- The total quantity of monomers and other reactants (including cross linking, chain transfer agents, and post polymerization reactants) which are not listed in the PICCS is less than 2% (by weight);
- A new polymer if two or more of the top (by weight) monomers are included in the definition of another polymer listed in the PICCS (a new addition compared to the consultation paper)

For PLCs, they should fall under either of the following two categories:

Category 1

- Number Average Molecular Weight (NAMW) $\geq 10,000$ Da;
- Less than 5% of oligomers are with Molecular Weight (MW) lower than 1,000 Da and less than 2% of oligomers with MW lower than 500 Da; and

The Australian Pesticides and Veterinary Medicine Authority (APVMA) has undertaken some maintenance on the APVMA MRL Standard to standardise formatting and the expression of commodity names in Tables 1 and 4.

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- Functional Group Equivalent Weight (FGEW) for cationic polymers $\leq 5,000$ Da.

Category 2

$1,000\text{Da} \leq \text{NAMW} < 10,000$ Da,

- Less than 25% of oligomers are with MW lower than 1,000 Da and less than 10% of oligomers with MW lower than 500 Da;
- No reactive functional groups (RFGs) are over 2% by weight

To apply for exemption of polymers or PLCs, manufacturers or importers should submit the following documents or items:

- Duly notarised and accomplished polymer exemption form;
- Polymer information like specific chemical name, chemical structure, CAS number (if available), and uses of the polymer;
- Safety Data Sheet (SDS) for the polymer alone or a mixture/product where the polymer is part of the composition;
- 100% composition including CAS numbers of monomers and other reactants;
- Data which can prove that the polymer or PLC satisfies any of the conditions above (Gel Permeation Chromatography, Infrared Spectroscopy, etc.).
- Request for confidential business information through an official letter with justification
- Processing fee amounting to Php 1,500.00

The Lists of RFGs and Reactants are attached to the Administrative Order as Annexes I and II to provide further guidance for manufacturers and importers of polymers and PLCs. Further information is available at: [Administrative Order for Polymers and Polymer of Low Concern Exemption from the PMPIN Process](#)

Chemlinked, 15 November 2019

<http://chemlinked.com/en/news>

China Punishes Three Manufacturers Violating New Chemical Notification Obligations

2019-11-22

Two eye-catching public announcements were published on China MEE's website, stating that three Chinese companies were fined for violations of

Two eye-catching public announcements were published on China MEE's website, stating that three Chinese companies were fined for violations of the new chemical notification obligations.

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the new chemical notification obligations. They have manufactured new chemical substances without notification.

The three companies are:

- Jiangsu Liside New Material Co., Ltd. (a fine of RMB 20,000)
- Shandong Sihuan Pharmaceutical Co. Ltd. (a fine of RMB 15,000)
- Jinan Shenghong Pharmaceutical Technology Co. Ltd. (a fine of RMB 10,000)

The punishment caused quite a sensation among the industry stakeholders. Although the current punishment (a fine up to RMB 30,000 only) for violating the Measures for the Environmental Management of New Chemical Substances (MEP Order 7) are not effective deterrents, the public disclosure of the offending companies' information is a harsher disincentive to deter others and increase compliance with new chemical notification obligations. Also, it is a signal that regulatory enforcement will be enhanced and we will see more supervisory activities. Shanghai has been conducting a citywide supervision campaign on new chemicals since 2017 and some other provinces have followed this model, e.g. Shandong Province and Jiangsu Province.

In addition, the new Regulation on Environmental Risk Assessment and Control of Chemical Substances under development will impose more severe punishment on such violators. As proposed, a fine between RMB 500,000 and RMB 1 million shall be imposed; if severe consequences are caused, a fine between RMB 1 million and RMB 2 million shall be imposed. The significant increase in financial penalties will definitely serve to raise the awareness of the manufacturers and importers of new chemicals in China. Further information is available at: [announcements](#)

Chemlinked, 20 November 2019

<http://chemlinked.com/en/news>

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EPA Finalises Universal Waste Rule for Hazardous Aerosol Can Wastes, Streamlining Requirements for Their Management

2019-11-22

On 15 November 2019, the Administrator of the United States Environmental Protection Agency (EPA) signed a final rule to classify and regulate hazardous aerosol can wastes as “universal wastes” under the federal Resource Conservation and Recovery Act (RCRA) hazardous waste rules. Once the rule becomes effective, hazardous aerosol can wastes will be subject to substantially reduced requirements for collection and transport, in order to facilitate and encourage environmentally sound recycling or disposal. However, the ultimate recycling and disposal facilities will remain subject to essentially the same requirements as currently apply. As discussed below, even though the final rule is largely consistent with existing requirements for other universal wastes, and even though EPA has finalised the proposal with only limited changes, there are several aspects of the rule that warrant special attention. The final rule builds on existing universal waste requirements for other ubiquitous hazardous wastes, such as batteries, lamps, mercury-containing equipment, and certain pesticides. *See generally* 40 C.F.R. Part 273. Among other things, the aerosol can wastes will no longer have to be labelled as hazardous wastes (although they will be subject to reduced marking requirements), they may be stored for up to one year or even longer in some cases (rather than just 90 days for large quantity generators), they may be transported offsite without a hazardous waste transporter or hazardous waste manifest, and collection facilities not engaged in treatment or disposal will not have to be permitted as hazardous waste storage facilities. In addition, only large handlers of universal wastes (*e.g.*, facilities that accumulate 5000 kg or more of total universal wastes at any time) will be required to notify EPA and track shipments of the hazardous aerosol can wastes. Aerosol can wastes generated by households and Very Small Quantity Generators (VSQGs) meeting applicable requirements will remain exempt from the RCRA regulations. However, all aerosol wastes will remain subject to applicable requirements under the U.S. Department of Transportation (DOT) Hazardous Materials Regulations (HMR) (although under those rules, if aerosol cans are classified as universal wastes, they will not be subject to the enhanced DOT requirements that normally apply to RCRA hazardous wastes). *See* 49 C.F.R. § 171.8 (defining “hazardous

On 15 November 2019, the Administrator of the United States Environmental Protection Agency (EPA) signed a final rule to classify and regulate hazardous aerosol can wastes as “universal wastes” under the federal Resource Conservation and Recovery Act (RCRA) hazardous waste rules.

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wastes" for purposes of the HMR as materials subject to federal hazardous waste manifest requirements). Several key aspects of the final rule are discussed below. We note that the discussion here is based solely on the pre-publication version of the final rule and preamble. It is possible (though unlikely) that there may be some substantive changes in the rule when it is published in the Federal Register. In addition, EPA's Response-to-Comments document and economic assessment for the rule (neither of which are currently publicly available) may provide a further gloss on some of the issues addressed here.

Definition of Aerosol Can

The proposed rule would have limited the definition of "aerosol cans" subject to the rule to containers that use gas to "aerate and dispense any material ... in the form of a spray or foam." In this way, the proposal would have excluded cans that dispense products without aeration (*e.g.*, shaving gels) and cans that release only gas (*e.g.*, spray dusters or aerosol horns). In response to comments, EPA modified the definition in the final rule so that it is more inclusive and consistent with DOT rules. Under the final rule, cans that dispense products without aeration will be eligible for management as universal wastes. However, gas-only products will be excluded. DOT is currently considering a petition to revise its definition to include these products, consistent with international rules for dangerous goods transport. See Petition of the Consumer Specialty Products Association, *et al.* to DOT (September 28, 2017). Unfortunately, the preamble to EPA's final rule does not mention this petition, and it is unclear if the Agency would amend the definition in the universal waste rule if/when DOT changes its definition.

Status of Aerosol Cans with Evidence of Leakage/Damage

The proposed rule would have excluded from the scope of the universal waste rule any aerosol cans that "show evidence of leakage, spillage, or damage that could cause leakage under reasonably foreseeable conditions." Commenters expressed concern that this proposed limitation was highly ambiguous, could effectively eviscerate the rule and was unnecessary from an environmental perspective (since EPA could simply require more protective packaging for leaking aerosol cans). In the final rule, the Agency agreed with the commenters and added new provisions specifying that "[u]niversal waste aerosol cans that show evidence of leakage must be packaged in a separate closed container or overpacked with absorbents, or immediately punctured and drained." EPA also

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modified the definition of aerosol can so that it no longer requires that cans be “intact” to be classified as universal wastes.

Status of Empty Aerosol Cans

The final rule, like the proposed rule, excludes aerosol cans that meet the regulatory definition of an empty container. This exclusion raises a number of issues, as discussed below:

Commenters on the proposed rule asked EPA for clarification about when aerosol cans are properly deemed empty. They noted that it is unclear how the regulatory definition of empty and related Agency guidance applies to aerosol cans. EPA largely side-stepped this issue in the final rule. It merely restated the regulations and guidance and said that further clarifications or modifications to the relevant rules were outside the scope of the rulemaking. Commenters raised questions about the relationship of the exclusion for empty cans with past EPA statements that such cans may sometimes exhibit the characteristic of reactivity. See EPA, RCRA Hotline Report (September 1987) ([RCRA Online #13027](#)) (“Irrespective of the lack of contained waste, [empty] aerosol cans would be a RCRA hazardous waste [to the extent] they demonstrate the hazardous characteristic of reactivity”). Neither the final rule nor the preamble addresses this issue. The proposal left open the question as to whether empty cans could voluntarily be managed as universal wastes. In the preamble to the final rule, EPA clarified that empty cans may be managed as universal wastes, even though they do not have to be.

Other Issues Related to the Applicability of RCRA to Aerosol Cans

Commenters on the proposed rule asked EPA for guidance on several fundamental issues associated with the applicability of RCRA to aerosol cans in the first instance. For example, they requested guidance on the extent (if any) to which aerosol cans destined for recycling are properly classified as solid wastes (and thus potentially hazardous wastes). The commenters also asked the Agency for guidance about when (if ever) waste aerosol cans (empty or non-empty) might be classified as reactive hazardous wastes, and (as noted above) when aerosols cans qualify as empty. However, the final rule and preamble are essentially silent on these issues. Moreover, even though EPA had previously committed to providing such guidance as part of its 2016 strategy for addressing the applicability of RCRA to the retail sector, the preamble to the final rule states that “EPA has [now] completed all commitments made in the Retail Strategy,” which suggests that the guidance may not be forthcoming. See EPA, [“Strategy for Addressing the Retail Sector under the Resource Conservation and](#)

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Recovery Act's Regulatory Framework" (September 12, 2016) at 6 ("EPA is developing a guide on how to recycle aerosol cans under the existing Subtitle C recycling exclusions").

Allowance of Certain Processing Activities by Handlers

The final rule allows handlers of universal waste aerosol cans to perform certain limited activities, "as long as each individual aerosol can is not breached and remains intact":

- Sorting aerosol cans by type.
- Mixing intact cans in one container.
- Removing actuators to reduce the risk of accidental release.

Although there may be some uncertainty, it appears that these activities may only be performed with intact containers, even though (as noted above) EPA has modified the definition of aerosol can to eliminate the "intact" requirement. For these purposes, it appears that a can with a removed (or possibly missing) actuator would still be viewed as intact, assuming the integrity of the can has not otherwise been compromised.

Special Rules for Puncturing and Draining of Aerosol Cans

Even though puncturing and draining of hazardous aerosol cans is currently exempt from RCRA regulation if performed as part of a recycling process, the final rule imposes new requirements for puncturing and draining by handlers of universal waste aerosol cans (whether they are processing their own aerosol can wastes or those generated by others). For example, these activities will have to be performed using a device (commercial or "homemade") that is specifically designed to do so in a safe manner that effectively contains residual contents and emissions. The handler will have to develop and follow written procedures to ensure proper operation of the equipment (including segregating incompatible wastes and preventing fires/releases) and to respond to any spills or releases, and it will have to ensure relevant employees are adequately trained. The contents drained from the aerosol cans will have to be "immediately" transferred to a tank or container meeting applicable hazardous waste generator requirements (e.g., the requirements for 90-day accumulation units or satellite accumulation units). A hazardous waste determination will have to be performed on the drained contents, and the materials will have to be managed accordingly. The drained cans will have to be recycled, and since they will be eligible for the RCRA exemption for recycled scrap metal, they will not have to be subjected to a hazardous waste determination. EPA notes that all of these activities

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must be conducted in compliance with all applicable federal, state, and local laws and regulations related to solid or hazardous wastes, as well as occupational safety and health.

Adoption by the States

EPA states that the final rule is “less stringent than the current federal program” and thus “states . . . will not have to adopt the universal waste regulations for aerosol cans.” However, as noted above, the new rules for puncturing and draining are more stringent than current rules (because those activities are currently exempt from regulation if performed as part of a recycling process), which casts doubt on the Agency’s claim that the final rule (in its entirety) is less stringent. Despite requests from commenters for EPA to address this issue, the final rule and preamble are silent on the requirements that will apply to aerosol cans shipped from, to, or through states that do not adopt (or have not yet adopted) a universal waste rule for aerosols. In prior universal waste rules for other wastes, EPA has claimed that, in such circumstances, the waste would have to be transported in the non-universal-waste states by a hazardous waste transporter and with a hazardous waste manifest. *See, e.g.*, 64 Fed. Reg. 36,466, 34,483 (July 6, 1999) (universal waste rule for lamps) (“[if] a [federal universal waste is] transported across a State in which it is subject to the full hazardous waste regulations . . . [t]ransport through the State must be conducted by a hazardous waste transporter and must be accompanied by a manifest”); 70 Fed. Reg. 45,508, 45,517 (August 5, 2005) (universal waste rule for mercury-containing equipment) (same). However, there appears to be a strong argument under the Hazardous Materials Transportation Act (HMTA) that state rules requiring a manifest are pre-empted if (as would be the case here) federal law does not require a manifest. *See, e.g.*, Letter from Michael Shapiro, Director, Office of Solid Waste, EPA, to Richard J. Barlow, Chair, Northeast Waste Management Officials’ Association (June 11, 1996) (RCRA Online #14135) (“[although] pre-emption authorities are [generally] quite foreign to RCRA . . . they are introduced into the transporter area by the statutory directive in RCRA to maintain consistency with the DOT framework”); 49 Fed. Reg. 10,490, 10,492 (March 20, 1984) (federal law “prohibit[s] States from requiring separate State manifests or other information to accompany waste shipments”); *id.* at 10,494 (“States are not precluded from setting up another system of forms . . . as long as the system does not interfere with the actual shipment of waste [and] transporters [are] not . . . required to carry these forms”). Similar arguments may apply with respect to

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state requirements to use a hazardous waste transporter for a federally designated universal waste.

Next Steps

The final rule is expected to be published in the Federal Register in the next few weeks and will become effective at the federal level six months later, or approximately in early June 2020. The rule will not become effective in most states unless and until they act to adopt the rule, which (as discussed above) EPA says they will not be required to do (on the ground that the rule is less stringent than existing requirements). However, because several states have previously classified hazardous aerosol can wastes as universal wastes (e.g., California, Colorado, Utah, New Mexico, and Ohio) and another is poised to do the same (*i.e.*, Minnesota), it can be reasonably expected that virtually all states will eventually follow EPA's lead on this issue (possibly with some variations).

National Law Review, 19 November 2019

<http://www.natlawreview.com>

Environmental Protection and Regulatory Reform

2019-11-22

The United States Environmental Protection Agency (EPA), along with the rest of the federal government, released the Fall 2019 *Unified Agenda of Regulatory and Deregulatory Actions and Regulatory Plan* (Fall Regulatory Agenda and Annual Regulatory Plan), which provides updates to the public about regulatory activity. "EPA's Fall Regulatory Agenda and Annual Regulatory Plan continue to advance the agency's core mission of protecting human health and the environment through regulatory reform and modernisation," said EPA Administrator Andrew Wheeler. "Under President Trump, EPA has finalised 47 deregulatory actions, saving Americans nearly \$5 billion in regulatory costs. By creating a climate of regulatory certainty, we're able to breathe new life into local economies around the country." EPA's Fall Regulatory Agenda includes information on the agency's regulatory and deregulatory activities under development within the next 12 months. The Agenda includes 56 actions that are expected to be deregulatory and 37 actions appearing for the first time. The Annual Regulatory Plan includes EPA's statement of regulatory priorities and additional information about 34 priority actions that the agency plans to propose or complete in the coming year. Among those are multiple actions focused on emerging contaminants, including Per-

The United States Environmental Protection Agency (EPA), along with the rest of the federal government, released the Fall 2019 Unified Agenda of Regulatory and Deregulatory Actions and Regulatory Plan (Fall Regulatory Agenda and Annual Regulatory Plan), which provides updates to the public about regulatory activity.

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and Polyfluoroalkyl Substances (PFAS). Other priority actions include the following:

- Revised Definition of “Waters of the United States” (Step 2);
- Oil and Gas NSPS Reconsideration; and
- Updating Regulations on Water Quality Certification.

To access EPA’s Fall 2019 *Unified Agenda of Regulatory and Deregulatory Actions and Regulatory Plan*: <https://www.reginfo.gov/public/do/eAgendaMain>.

For more information about regulatory reform at EPA: <https://www.epa.gov/laws-regulations/epa-deregulatory-actions>

U.S EPA, 20 November 2019

<http://www.epa.gov>

Hundreds of former US industrial sites are at risk of releasing toxics because of climate change

2019-11-22

Nearly 950 US Superfund sites may fail to contain toxic waste because of climate change, says a new report by the US Government Accountability Office. Consequently, the GAO recommends that the Environmental Protection Agency, which oversees the Superfund clean-up program for sites that are neither federal facilities nor on federal land, better prepare and take precautions to avoid the worst impacts of climate change. Those impacts include flooding, wildfires, sea level rise, and storm surge, according to the report, which includes an interactive national map of the sites. The GAO, which audits and investigates government programs for the US Congress, notes that the EPA has taken some actions but needs to do more to incorporate potential climate impacts on human health and the environment into its decision making to ensure long-term protection at these sites. Superfund is a national program for cleaning up or containing hazardous chemicals at former industrial sites. The EPA currently oversees 1,571 such sites, which are contaminated with substances such as arsenic, dioxin, and lead. International scientists have warned that climate change may make some natural disasters more frequent or more intense, damaging Superfund sites and releasing contaminants into the surrounding environment, including nearby communities, the report notes. For instance, the report offers the example of the American Cyanamid site in New Jersey, a 233 hectare (575 acre) former chemical and pharmaceutical manufacturer. After 90 years of

EPA must better prepare for more frequent or severe weather events affecting Superfund sites, report says

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operation, a mix of chemicals including toxic acid tars remained held in on-site waste ponds. After flooding from Hurricane Irene in 2011, the EPA tried to contain the contamination with a series of partially successful efforts. In 2018, the EPA finally ordered that the tars be removed and treated off-site. The EPA, however, takes issue with the GAO's assessment. "The EPA strongly believes the Superfund program's existing processes and resources adequately ensure that risks and any effects of severe weather events, are woven into risk assessments," wrote Peter Wright, assistant administrator for the EPA's Office of Land and Emergency Management, to the GAO in [response to the report](#). The GAO report was requested by 11 Democratic members of Congress, who wrote in a [letter to the EPA](#): "We believe that EPA's refusal to implement GAO's recommendations could result in real harm to human health and the environment as the effects of climate change become more frequent and intense." They also ordered the EPA to specifically demonstrate how its Superfund policies address climate change.

Chemical & Engineering News, 20 November 2019

<http://pubs.acs.org/cen/news>

EPA Will Hold Public Meeting on TSCA New Chemicals Program

2019-11-22

The United States Environmental Protection Agency (EPA) will hold a public meeting on 10 December 2019, to engage with interested stakeholders on the implementation of EPA's Toxic Substances Control Act (TSCA) New Chemicals program. At the meeting, EPA will:

- Provide an overview of EPA's updated "Working Approach" document that builds upon EPA's November 2017 "New Chemicals Decision-Making Framework: Working Approach to Making Determinations under Section 5 of TSCA";
- Demonstrate how EPA has used concepts in the "Working Approach" document to reach conclusions and make determinations under TSCA Section 5(a)(3) using specific case examples;
- Provide an update on confidential business information (CBI) process improvements and clarifications; and
- Discuss its progress on transparency in the TSCA New Chemicals program.

The United States Environmental Protection Agency (EPA) will hold a public meeting on 10 December 2019, to engage with interested stakeholders on the implementation of EPA's Toxic Substances Control Act (TSCA) New Chemicals program.

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By the end of 2019, EPA intends to announce the availability of the updated "Working Approach" document and provide an opportunity for written public comment. EPA states that feedback from the public meeting and comments received will help inform its ongoing efforts to improve the way EPA reviews new chemicals under TSCA. Details regarding the meeting are available in the prepublication version of the Federal Register notice announcing the meeting.

Background

EPA states in the prepublication version of the Federal Register notice that after considering comments received on the 2017 version of the "Working Approach" document and based on additional implementation experience, EPA is updating the "Working Approach" document. Later in December 2019, EPA will announce the availability of the updated document after the public meeting and will hold a public comment period. According to the notice, EPA expects the updated document to provide further clarity and detail on EPA's approach and practices, including: (1) EPA's general guiding principles and concepts for making determinations on new chemical notices submitted to EPA under TSCA Section 5; (2) the decision-making logic and the key questions that EPA must address; and (3) a discussion of how EPA might apply the working approach to reach one of the five new chemical determinations allowable under the statute.

National Law Review, 16 November 2019

<http://www.natlawreview.com>

EUROPE

Poison Centre Notification database ready for Member States on-boarding

2019-11-22

Appointed Bodies and Poison Centres will have at their disposal search criteria such as the unique formula identifier (UFI) in order to access information relating to emergency health response submitted through the European Chemicals Agency's (ECHA) Submission portal. Users will be able to view the information in PDF and download it in IUCLID format as well. While many Member States have indicated that they will only accept notifications submitted through the ECHA Submission portal from 1 January 2021 onwards, they have the opportunity to start the

Appointed Bodies and Poison Centres will have at their disposal search criteria such as the unique formula identifier (UFI) in order to access information relating to emergency health response submitted through the European Chemicals Agency's (ECHA) Submission portal.

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on-boarding preparations and get familiar with the PCN database now. More information will be provided for appointed bodies in accompanying documentation and in a dedicated webinar on 3 December 2019.

Chemycal, 20 November 2019

<http://chemycal.com>

Danish executive order on disinfectants updated

2019-11-22

A number of changes in the Danish executive order on disinfectants in the food industry have become effective. The changes mainly concern clarification of certain provisions, including:

- Remedies for udder hygiene is no longer covered by the legislation. Only teat dips and teat sprays are to be approved according to the executive order. This will also imply a few changes in the labelling requirements.
- Changes in the name of an approved product, or identical products marketed under different names, must be approved. You are not permitted to market non-approved products.
- Products must contain active substances that are approved or under evaluation. Moreover, suppliers of active substances must be Article 95 compliant (the list of active biocidal substance and product suppliers of the European Biocidal Products Regulation).

Addition of a transitional scheme allowing businesses to market products already approved according to the previous executive order from 2013.

DHI Newsletter, 15 November 2019

<http://www.dhigroup.com>

Hazardous substances turn up in EU products

2019-11-22

Some 88% of chemical suppliers are failing to tell European customers when their products contain substances of very high concern (SVHC), according to a study by the European Chemicals Agency (ECHA), the body responsible for implementing chemical regulations in the European Union. The failure is a breach of the regulations, which classify SVHCs as being present when at concentrations of more than 0.1% by weight. The same study found that SVHCs are present in 12% of consumer products such as footwear and electronic accessories. Chemicals classified as SVHCs have

A number of changes in the Danish executive order on disinfectants in the food industry have become effective.

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restricted uses. ECHA didn't say whether SVHCs in the products made them unsafe, as this was outside the scope of the study. For the study, ECHA inspected 682 consumer products made by 405 companies across 15 European countries. SVHCs identified in the consumer goods include various phthalates, heavy metals, and short-chain chloroparaffins. ECHA says the problem can be solved if companies improve knowledge of their products and better communicate this information to customers. The agency plans to publish new guidance on communication in the supply chain late next year. But the Swedish environmental group ChemSec says ECHA should do more. It wants clear follow-up with a plan for how enforcement officials will tackle the issue. "We have had the same problems for more than 10 years. Carrots are not enough. It's time to use the stick," ChemSec deputy director Frida Hök says.

Chemical & Engineering News, 20 November 2019

<http://pubs.acs.org/cen/news>

PAH levels in consumer products should be lower

2019-11-22

PAH substances can be carcinogenic but are used in many consumer products. German institute estimates that it is possible to minimise the PAH content to below 0.2 mg/kg. The German BfR institute for risk assessment estimates that it is possible to minimise the PAH content in consumer products to below 0.2 mg/kg. Many polycyclic aromatic hydrocarbons, or PAHs, are carcinogenic and safe dose levels cannot be derived for carcinogenic substance mixtures. PAHs are used in many consumer products with long-term or repeated skin contact. BfR estimates that it is technically feasible to minimise the PAH content to 0.2 mg/kg in all common rubber materials, elastomers and plastics. Lowering the levels in plastic and rubber parts of products will further reduce consumers' exposure to PAHs. The BfR evaluation has been reached in connection with their work on development of German criteria for the GS certification mark for product safety.

DHI Newsletter, 15 November 2019

<http://www.dhigroup.com>

PAH substances can be carcinogenic but are used in many consumer products.

REACH Update

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Companies need to improve communication of hazardous substances in products

2019-11-21

A Forum pilot enforcement project in 15 participating countries has found that 12 % of inspected products contain substances of very high concern (SVHCs). The majority (88 %) of suppliers of these products are failing to communicate sufficient information to their customers about SVHCs in products they supply. The results of the pilot project show that companies need to improve their knowledge on the products they supply to their customers and to better communicate information so that products containing substances of very high concern can be used safely. In this project, 405 companies across 15 countries were inspected and 682 articles were checked. 84 (12 %) of the 682 articles were found to contain substances listed as being of high concern to human health or the environment (Candidate List substances) in concentrations above 0.1 % weight by weight. The products checked by inspectors were selected especially as they were highly likely to contain targeted Candidate List substances. Such products included clothing, footwear and home textiles; wires, cables and electronic accessories; plastic or textile floorings; wall coverings; and other plastic and rubber products. "While nearly 90 % of the products do not contain substances of very high concern above 0.1 %, the report clearly shows a failure of communication in the supply chain. Improvement is needed if we want to make REACH work in all aspects, contribute to the objectives of the circular economy and to have a good database as required under the Waste Framework Directive," says *Erwin Annys*, Head of ECHA's Support and Enforcement Unit. The duty to communicate information down the supply chain about the presence of Candidate List substances in articles was applicable to 45 articles containing those substances. Suppliers did not do so for 40 (89 %) of them, and 37 out of 42 companies (88 %) failed to provide the name of the substance to recipients of their articles. For companies supplying articles directly to consumers only, 22 suppliers (51 %) out of 43 were considered to have insufficient information available to fulfil their obligation to provide required information to consumers, when requested. The results show that, in almost all cases, only the name of the Candidate List substance was communicated in the supply chain, and this may not be sufficient to allow safe handling. For the 12 % of articles placed on the EU market containing Candidate List substances, the results of the project show a high rate of non-compliance. This situation hinders the safe use of Candidate List substances in produced and imported articles, in particular those used by consumers. The ECHA Secretariat and the

A Forum pilot enforcement project in 15 participating countries has found that 12 % of inspected products contain substances of very high concern (SVHCs).

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Forum will further analyse the results from this enforcement project and the recommendations included in the Forum's final report, and consider further actions that could improve the situation.

Background

The Forum for Exchange of Information on Enforcement (Forum) is a network of authorities responsible for the enforcement of the REACH, CLP, BPR, PIC and POP regulations in the EU, Norway, Iceland and Liechtenstein. The term 'product' in this text refers to an article, defined by REACH as 'an object which during production is given a special shape, surface or design which determines its function to a greater degree than does its chemical composition'. Further information is available at:

- [Final report on the Forum Pilot Project on Substances in Articles](#)
- [Annex to the press release](#)
- [Enforcement Forum](#)
- [Forum Enforcement Projects](#)

ECHA, 15 November 2019

<http://echa.europa.eu>

Committees' opinions on restriction available

2019-11-21

The consolidated opinions of the Committees for Risk Assessment and Socio-economic Analysis for polycyclic aromatic hydrocarbons (PAHs) in granules and mulches used as infill material, submitted by The Netherlands, are available on the European Chemicals Agency website. Further information is available at: [Registry of restriction intentions](#)

ECHA News, 20 November 2019

<http://echa.europa.eu>

Public consultation on derogation for *in-situ* generated nitrogen on the basis of protecting cultural heritage

2019-11-21

Biocidal products should normally be authorised only if its active substances are approved or included in Annex I of the Biocidal Products Regulation. However, Article 55(3) allows a Member State to authorise a biocidal product containing a non-approved active substance, if the active substance is essential for the protection of cultural heritage and no

The consolidated opinions of the Committees for Risk Assessment and Socio-economic Analysis for polycyclic aromatic hydrocarbons (PAHs) in granules and mulches used as infill material, submitted by The Netherlands, are available on the European Chemicals Agency website.

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appropriate alternatives are available. Comments should be submitted by 18 January 2020 on whether *in-situ* nitrogen for product-type 18 (products for treatment against insects, arachnids and other arthropods) is essential for the protection of cultural heritage and whether appropriate (chemical or non-chemical) alternatives are available for the corresponding uses. Your comments will help the European Commission and the Member States competent authorities to take their decision. Further information is available at:

- [Give comments](#)
- [Derogations for protection of cultural heritage](#)

ECHA News, 20 November 2019

<http://echa.europa.eu>

R4BP 3 and SPC editor updated

2019-11-21

A new version of the SPC editor 2.4 was made available on 14 November 2019. It contains features to support the placement and management of comments beside each field of the SPC structure. Comments can be edited and deleted by users. Additional visual support has been introduced in the editor to facilitate the identification of the position and the number of comments in the file. R4BP 3 was also updated on the same day. Version 3.14 includes features to support the upload and/or exchange via ad hoc communication of SPCs containing comments. A validation rule has been introduced to prevent upload of SPCs with comments: SPCs will have to be free of comments to proceed in the workflows. Further information is available at:

- [R4BP](#)
- [Manuals](#)
- [SPC editor](#)

ECHA News, 20 November 2019

<http://echa.europa.eu>

A new version of the SPC editor 2.4 was made available on 14 November 2019.

Janet's Corner

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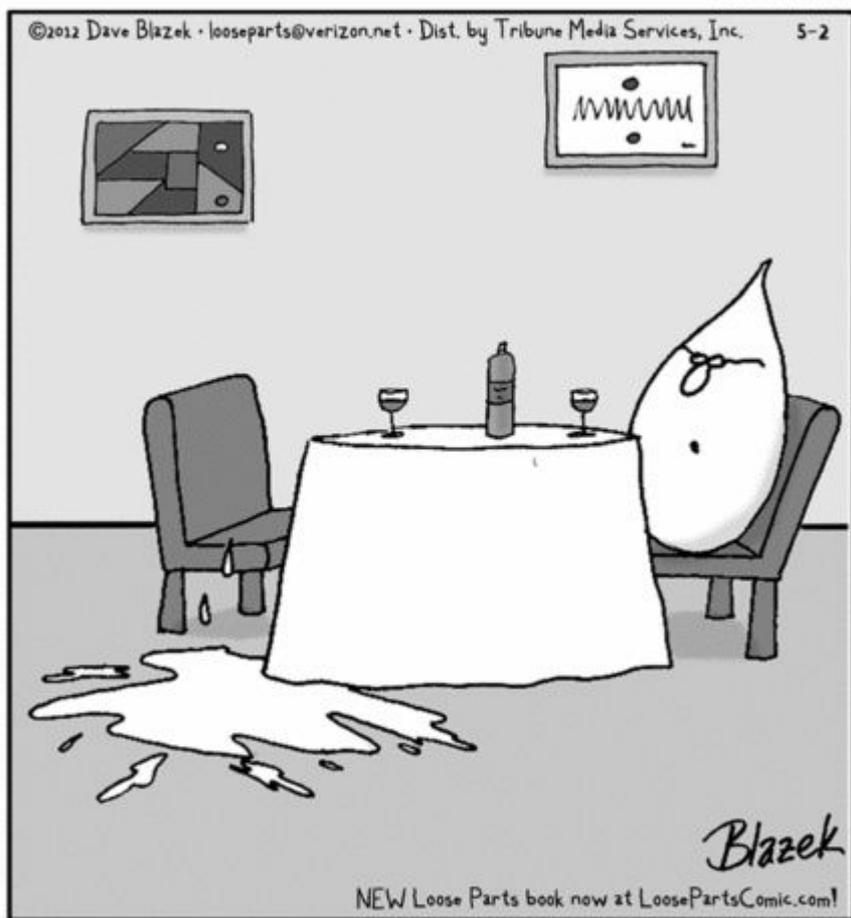
Break the Tension

2019-11-17

LOOSE PARTS

DAVE BLAZEK

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"Sorry. I thought a joke
would break the tension."

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1,3-Dichloropropene

2019-11-10

1,3-Dichloropropene, chemical formula C₃H₄Cl₂, is a clear to straw-coloured liquid with a sharp, sweet, irritating odour. [1]

1,3-Dichloropropene dissolves in water and evaporates easily. It is a by-product in the chlorination of propene to make allyl chloride [2]

USES [1,2]

1,3-Dichloropropene is used mainly in farming as a pesticide, specifically as a preplant fumigant and nematicide. It is widely used in the United States and other countries, but is in the process of being phased out in the European Union. It is also used in making other chemicals.

IN THE ENVIRONMENT [3]

In the environment, 1,3-Dichloropropene is quickly broken down in air, usually within several days. Some of the 1,3-dichloropropene in soil and water will evaporate into the air. The rest will be broken down.

SOURCES AND ROUTES OF EXPOSURE SOURCES OF EXPOSURE

Sources of Exposure [3]

The primary source of exposure to 1,3-dichloropropene is by breathing air containing it. This can occur either via contaminated workplace air or air around hazardous waste sites that contain it. Exposure may also occur through drinking contaminated water or touching contaminated soil where it is produced or used, or near hazardous waste sites that contain it.

Routes of Exposure [5]

The main routes of exposure to 1,3-dichloropropene are:

- inhalation,
- skin absorption,
- ingestion,
- skin and/or eye contact

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HEALTH EFFECTS [4]

Acute Effects

Acute inhalation exposure of humans after a tank truck spill resulted in mucous membrane irritation, cough, chest pain, and breathing difficulties. Effects on the lung, including emphysema and oedema, have been observed in rats acutely exposed to 1,3-dichloropropene by inhalation. Lung congestion and haemorrhage, ulcerations of the glandular stomach, haemorrhage of the small intestine, dark and patchy liver, and haemorrhage of the liver have been observed in rats acutely exposed to 1,3-dichloropropene in their diet or via gavage (experimentally placing the chemical in the stomach). Neurotoxic effects, including hunched posture, lethargy, ptosis, ataxia, and decreased respiratory rate, have also been observed in orally exposed rats. Acute animal tests in rats, mice, and rabbits have demonstrated 1,3-dichloropropene to have moderate acute toxicity from inhalation, moderate to high acute toxicity from oral exposure, and high acute toxicity from dermal exposure.

Chronic Effects

Chronic dermal exposure may result in skin sensitisation in humans. Damage to the nasal mucosa and urinary bladder are the primary health effects of rodents chronically exposed to 1,3-dichloropropene by inhalation. Hyperplastic lesions of the upper respiratory tract and degeneration of the olfactory epithelium in the nasal turbinates have been observed in chronically exposed rats and mice. Chronic inhalation exposure of mice has resulted in changes in the urinary bladder. In mice chronically exposed by inhalation, hyperplasia and hyperkeratosis of the forestomach and effects to the urinary bladder, liver, and kidneys have been observed. In one study, reversible cloudy swelling of the renal tubular epithelium was reported in rats chronically exposed by inhalation. Hyperplasia of the forestomach and decreased body weight resulted in rats exposed to 1,3-dichloropropene in the diet, and hyperplasia of the urinary bladder resulted in mice chronically exposed via gavage. The Reference Concentration (RfC) for 1,3-dichloropropene is 0.02 milligrams per cubic metre (mg/m³) based on hypertrophy/hyperplasia of the nasal respiratory epithelium in mice. The Reference Dose (RfD) for 1,3-dichloropropene is 0.03 milligrams per kilogram per day (mg/kg/d) based on chronic irritation of the forestomach in rats.

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Reproductive/Developmental Effects

A study of male workers engaged in the manufacture of 1,3-dichloropropene indicated no significant effect on fertility at exposure levels occurring in the work environment. No evidence of developmental toxicity was observed in rats or rabbits exposed to 1,3-dichloropropene by inhalation, but significant maternal toxicity was seen in both species. In one study of rats exposed by inhalation, fewer foetuses per litter were reported at the highest exposure concentration but maternal toxicity was also observed. In other studies, no adverse reproductive effects were observed in rats and mice exposed by inhalation.

Cancer Risk

Information on the carcinogenic effects of 1,3-dichloropropene in humans is limited. Two cases of histiocytic lymphomas and one case of leukaemia have been reported in emergency response personnel exposed to concentrated 1,3-dichloropropene vapours during clean-up of a tank truck spill. An increased incidence of bronchioalveolar adenomas has been reported in male mice exposed by inhalation but not in rats or female mice. Forestomach and liver tumours in rats and forestomach, urinary bladder, and lung tumours in mice have been observed in rodents exposed to 1,3-dichloropropene via gavage. Liver tumours were noted in rats exposed to 1,3-dichloropropene in the diet. EPA has classified 1,3-dichloropropene as a Group B2, probable human carcinogen.

SAFETY [1]

First Aid Measures

- Eye Contact: Immediately flush with large amounts of water for at least 15 minutes, lifting upper and lower lids. Remove contact lenses, if worn, while flushing. Seek medical attention immediately.
- Skin Contact: Quickly remove contaminated clothing. Immediately wash contaminated skin with large amounts of soap and water.
- Inhalation: Remove the person from exposure. Begin rescue breathing (using universal precautions) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Fire Hazards

- 1,3-Dichloropropene is a flammable liquid.
- Use dry chemical, CO₂, water spray or foam as extinguishing agents.

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- Poisonous gases are produced during a fire, including hydrogen chloride.
- Containers may explode during a fire.
- Use water spray to keep fire-exposed containers cool.
- Vapours may travel to a source of ignition and flash back.
- Vapour is heavier than air and may travel a distance to cause a fire or explosion far from the source.

Workplace Exposure Controls

Control measures include:

- enclosing chemical processes for severely irritating and corrosive chemicals,
- using local exhaust ventilation for chemicals that may be harmful with a single exposure, and
- using general ventilation to control exposures to skin and eye irritants.

The following work practices are also recommended:

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

Personal Protective Equipment

The following personal protective equipment is recommended when handling 1,3-Dichloropropene:

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- **Gloves and Clothing:** Wear personal protective equipment made from material that cannot be permeated or degraded by this substance. Safety equipment suppliers and manufacturers can provide recommendations on the most protective glove and clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.
- **Eye Protection:** Wear indirect-vent, impact and splash resistant goggles when working with liquids. Wear a face shield along with goggles when working with corrosive, highly irritating or toxic substances. Do not wear contact lenses when working with this substance.
- **Respiratory Protection:** Improper use of respirators is dangerous. Respirators should only be used if the employer has implemented a written program that takes into account workplace conditions, requirements for worker training, respirator fit testing, and medical exams. Where the potential exists for exposure over 1 ppm, use an approved supplied-air respirator with a full face-piece operated in a pressure demand or other positive-pressure mode. For increased protection use in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode.

REGULATION [6,7]

United States

ACGIH: American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) of 1 ppm, 4.5 mg/m³ TWA (Skin); Appendix A4 (Not Classifiable as a Human Carcinogen)

NIOSH: National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) of 1 ppm TWA; Potential carcinogen

Australia

Safe Work Australia: The recommended time weighted exposure limit is 1ppm over an 8-hour period.

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Gossip

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System provides cooling with no electricity

2019-11-12

Imagine a device that can sit outside under blazing sunlight on a clear day, and without using any power cool things down by more than 23 degrees Fahrenheit (13 degrees Celsius). It almost sounds like magic, but a new system designed by researchers at MIT and in Chile can do exactly that. The device, which has no moving parts, works by a process called radiative cooling. It blocks incoming sunlight to keep from heating it up, and at the same time efficiently radiates infrared light -- which is essentially heat -- that passes straight out into the sky and into space, cooling the device significantly below the ambient air temperature. The key to the functioning of this simple, inexpensive system is a special kind of insulation, made of a polyethylene foam called an aerogel. This lightweight material, which looks and feels a bit like marshmallow, blocks and reflects the visible rays of sunlight so that they don't penetrate through it. But it's highly transparent to the infrared rays that carry heat, allowing them to pass freely outward. The new system is described in a paper in the journal *Science Advances*, by MIT graduate student Arny Leroy, professor of mechanical engineering and department head Evelyn Wang, and seven others at MIT and at the Pontifical Catholic University of Chile. Such a system could be used, for example, as a way to keep vegetables and fruit from spoiling, potentially doubling the time the produce could remain fresh, in remote places where reliable power for refrigeration is not available, Leroy explains.

Minimising heat gain

Radiative cooling is simply the main process that most hot objects use to cool down. They emit midrange infrared radiation, which carries the heat energy from the object straight off into space because air is highly transparent to infrared light. The new device is based on a concept that Wang and others demonstrated a year ago, which also used radiative cooling but employed a physical barrier, a narrow strip of metal, to shade the device from direct sunlight to prevent it from heating up. That device worked, but it provided less than half the amount of cooling power that the new system achieves because of its highly efficient insulating layer. "The big problem was insulation," Leroy explains. The biggest input of heat preventing the earlier device from achieving deeper cooling was from the heat of the surrounding air. "How do you keep the surface cold while still allowing it to radiate?" he wondered. The problem is that almost all insulating materials are also very good at blocking infrared light and so would interfere with the radiative cooling effect. There has been a lot

Passive device relies on a layer of material that blocks incoming sunlight but lets heat radiate away

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of research on ways to minimize heat loss, says Wang, who is the Gail E. Kendall Professor of Mechanical Engineering. But this is a different issue that has received much less attention: how to minimize heat gain. "It's a very difficult problem," she says. The solution came through the development of a new kind of aerogel. Aerogels are lightweight materials that consist mostly of air and provide very good thermal insulation, with a structure made up of microscopic foam-like formations of some material. The team's new insight was to make an aerogel out of polyethylene, the material used in many plastic bags. The result is a soft, squishy, white material that's so lightweight that a given volume weighs just 1/50 as much as water. The key to its success is that while it blocks more than 90 percent of incoming sunlight, thus protecting the surface below from heating, it is very transparent to infrared light, allowing about 80 percent of the heat rays to pass freely outward. "We were very excited when we saw this material," Leroy says. The result is that it can dramatically cool down a plate, made of a material such as metal or ceramic, placed below the insulating layer, which is referred to as an emitter. That plate could then cool a container connected to it, or cool liquid passing through coils in contact with it, to provide cooling for produce or air or water.

Putting the device to the test

To test their predictions of its effectiveness, the team along with their Chilean collaborators set up a proof-of-concept device in Chile's Atacama Desert, parts of which are the driest land on Earth. They receive virtually no rainfall, yet, being right on the equator, they receive blazing sunlight that could put the device to a real test. The device achieved a cooling of 13 degrees Celsius under full sunlight at solar noon. Similar tests on MIT's campus in Cambridge, Massachusetts, achieved just under 10 degrees cooling. That's enough cooling to make a significant difference in preserving produce in remote locations, the researchers say. In addition, it could be used to provide an initial cooling stage for electric refrigeration, thus minimizing the load on those systems to allow them to operate more efficiently with less power. Theoretically, such a device could achieve a temperature reduction of as much as 50 C, the researchers say, so they are continuing to work on ways of further optimizing the system so that it could be expanded to other cooling applications such as building air conditioning without the need for any source of power. Radiative cooling has already been integrated with some existing air conditioning systems to improve their efficiency. Already, though, they have achieved a greater amount of cooling under direct sunlight than any other passive, radiative system other than those that use a vacuum system for insulation -- which

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is very effective but also heavy, expensive, and fragile. This approach could also be a low-cost add-on to any other kind of cooling system, providing additional cooling to supplement a more conventional system. "Whatever system you have," Leroy says, "put the aerogel on it, and you'll get much better performance."

EurekaAlert, 30 October 2019

<http://www.eurekaalert.org>

Scientists invent animal-free testing of lethal neurotoxins

2019-11-12

Animal testing will no longer be required to assess a group of deadly neurotoxins, thanks to University of Queensland-led research. Associate Professor Bryan Fry, of UQ's Venom Evolution Lab, said a new technique could replace conventional methods of testing paralytic neurotoxins, which previously required euthanasia of test subjects. "The old method, while extremely efficient, is limited in that it's slow and requires the euthanasia of animals in order to obtain the necessary tissue," Dr. Fry said. "Our new method uses optical probes dipped into a solution containing the venoms and we measure the binding to these probes—the critical factor—by analysing changes in the light reflected back. "It's going to reduce the numbers of animals used for research testing, but it also has significant biomedical implications." Testing and trialling paralytic neurotoxins is not only critical for research into anti-venoms, but also for the treatment of a wide array of diseases and conditions. "The team can now—without the use of animal subjects—screen venoms for non-target activities that may be relevant for drug design and development, helping treat all types of ailments," Dr. Fry said. "For example, we've showed that temple pit viper venom has an unusual cross-reactivity for the human alpha-5 receptor, which is a major target for conditions including colitis and smoking. "Who knows what other potential treatments the world's venoms could lead to—we're excited to find out." The technology relies on the development of synthetic peptides that correspond to nerve receptors, which tell our muscles to contract. "Neurotoxins, found in the venom of many types of snakes, cause paralysis by attaching to nerve receptors in our muscles, preventing the normal chemical binding process that naturally occurs in our bodies when we want to move," Dr. Fry said. "This is what stops a mouse fleeing from a snake after it has been bitten. "Since venoms bind to the synthetic peptides more vigorously than they do to human nerves, we're also investigating a new treatment of

Animal testing will no longer be required to assess a group of deadly neurotoxins, thanks to University of Queensland-led research.

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snakebite, using these peptides as 'decoys'. "The venom would bind to them instead of their original nervous system target in the human body. "Many species of deadly snake lack an effective anti-venom, so these sorts of applications may help meet this critical need." This underscores the flexibility of this novel technique and why we're so excited about this breakthrough." The research has been published in *Toxins*.

Phys.org, 29 October 2019

<http://phys.org>

Concrete with improved impact endurance for defence structures

2019-11-12

Engineers from the Military Studies Centre at Far Eastern Federal University (MSC FEFU) developed concrete with improved impact endurance and made of up to 40 percent waste from rice husk cinder, limestone crushing waste and siliceous sand. The new concrete is six to nine times more crackle-resistant than the types produced under GOST standards. The results are published in *Inorganic Materials: Applied Research*. The new concrete is suitable for the construction of military and civil defence structures, load-carrying structures of nuclear power plants, or for buildings in the Arctic. The endurance of the new type of concrete increases with according to the impact affecting it. A slab of the material exhibits the so-called 'rubber effect': it contracts and becomes springy, but doesn't crack. According to the engineers, the construction absorbs impact due to its dynamic viscosity. This effect is caused by the reinforcement of concrete, in this case, by adding metal or touchstone fibres to it. Impact-proof concrete can resist not only shell hits, but also tsunami waves. Moreover, it has seismic stability. During the pouring process, the concrete self-seals, which means it can be used to create complex structures, including underground constructions. "We've balanced the components with the accuracy of 0.5 percent. It was important for us that the concrete holds up until the first crack for as long as possible, because after a concrete structure cracks, its deterioration is just a matter of time. Today, the whole world is working on counter-terrorist security facilities that would defend other structures from a shell hit or a plane crush. We've approached this issue from our own angle and developed an impact-proof material. In the next stage of our work, we want to create radiation-resistant concrete," said Lieutenant-Colonel Roman Fediuk, a professor at the Military Studies Centre at Far Eastern Federal University. According to him, a technological scheme for the manufacture of the new concrete has

Engineers from the Military Studies Centre at Far Eastern Federal University (MSC FEFU) developed concrete with improved impact endurance and made of up to 40 percent waste from rice husk cinder, limestone crushing waste and siliceous sand.

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already been developed, and negotiations about its implementation are underway. The scheme would not require any extensive investments or modernization of facilities. The manufacture of the impact-proof concrete can be even more cost-effective than GOST-based types, as it contains less cement and more waste products. MSC FEFU has a separate scientific school working on the development of composite materials for special facilities, as well as civil construction. The work of the engineers is based on the principle of naturalness—they want their concrete to be as stable as natural stone. This principle is promoted by a branch of science called geonics or geomimetics. The groundwork of this field was laid by Professor Valery Lesovik from Shukhov Belgorod State Technological University, a corresponding member of the Russian Academy of Architecture and Construction Sciences. Earlier this year FEFU engineers together with their colleagues from Kazan State University of Architecture and Engineering presented a new type of concrete with increased initial strength that would speed the concrete pouring process by three to four times. This type of concrete doesn't crack or leak, is resistant to low temperatures, and may be used for building in the Far East and in the conditions of the extreme North.

Phys.org, 31 October 2019

<http://phys.org>

A “revolutionary” study could mean relief for millions with a common disease

2019-11-12

Diseases like celiac, type 1 diabetes, and multiple sclerosis have no cure and are notoriously hard to treat, but a sneaky way to trick the immune system into operating differently could save the lives of millions of Americans living with those conditions. Scientists at Northwestern University have discovered that a new approach to treating autoimmune diseases and allergies—which plague an estimated 50 and 32 million Americans respectively— involving nanotechnology. Tiny tech could revolutionise the way we treat autoimmune diseases and allergies. In the study, scientists used nanotechnology to reset the immune system, and reversed celiac disease for two weeks. Celiac is a disease where the immune system attacks the small intestine after consuming gluten. People living with celiac try desperately to avoid eating gluten, but the new treatment could mean they never have to give up pasta or bread again. The study's findings were presented in Barcelona at the European Gastroenterology Week conference. Stephen Miller, Ph.D., professor of

Scientists can now trick the immune system using tiny tech.

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microbiology and immunology at Northwestern University Feinberg School of Medicine, calls it “revolutionary.” “This is a proof of concept, early study that’s extremely encouraging,” Miller tells Inverse. “This is really the beginning of a revolution.”

The power of tiny tech

Miller has been refining the technology for decades. His team takes a Trojan-horse approach, sneaking biodegradable nanoparticles containing allergens or antigens into the body. These nanoparticles are cheap and relatively easy to make, Miller explains. Encased in a friendly shell, the immune system learns not to attack these offending particles. When the nanoparticles are injected, the immune system doesn’t mind, seeing the particles as harmless debris. The nanoparticles are then eaten up by macrophages, cells that clean up bacteria and harmful substances, like janitors sweeping up the floor after a mess. “The vacuum-cleaner cell presents the allergen or antigen to the immune system in a way that says, ‘no worries, this belongs here,’” Miller said in a statement accompanying the research. “The immune system then shuts down its attack on the allergen, and the immune system is reset to normal. The technology teaches the immune system that the allergens and antigens are safe. So celiac patients won’t attack their small intestines, and people allergic to peanuts won’t have an allergic reaction.

Treatment possibilities are endless

Theoretically, if you can target the antigen or allergen, you can use the same technology to treat any autoimmune disease or allergy. “The beauty of the system is simply by using the same nanoparticle carrier and switching the antigen that’s inside, you have the theoretical possibility to actually treat any autoimmune or allergic disease,” Miller explains. About one in 133 people have celiac, a gut-wrenching autoimmune disease that racks the intestine and causes symptoms like abdominal pain, fatigue, and diarrhoea, all because of gluten, a protein contained in common foods. When people with celiac eat foods like pasta, bread, cereal, their immune system attacks their small intestine. Over time, these attacks damage the villi, tiny finger-like projections. Damaging villi makes it harder for our bodies to absorb nutrients. Kids with celiac can have hampered growth and development, while adults can suffer anaemia, loss of bone density and nervous system injury. Celiac has no cure, and is typically managed with immunosuppressants, which can heighten the risk of infection and even cancer. Or, celiac patients simply avoid gluten entirely, a seemingly small lifestyle change that can be costly and socially-

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awkward. In an effort to find another treatment, Miller and his team tested their nanotechnology in a phase 2 clinical trial including thirty-four people with celiac. They loaded nanoparticles with gliadin, the major component of dietary gluten, and injected them into bloodstreams of celiac patients twice. A week after the second treatment, patients were fed gluten for two weeks. Without treatment, patients' immune systems attacked the small intestine. But patients who received treatment, showed 90 percent less immune inflammation compared to untreated patients. By stopping the inflammatory response to gluten, the nanoparticles protected the small intestine from damage. Treated patients still experienced nausea, abdominal distention, headaches, and back pain, but those symptoms may be attributed to changes in the microbiome, Miller says. Theoretically, these patients may eventually be able to add gluten back into their diets.

Immune reset

This is the first clinical trial that showed it is possible to induce immune tolerance to gluten, the study's authors say. Miller isn't sure how long the effects would last, or what treatment would look like in clinical practice. It's possible one treatment could reset the immune system for life, or it could take annual or even monthly injections. Miller's team won't know clinical application until many more clinical trials are conducted. "The hope is if we reset the immune system using this tolerance procedure, patients will be able to resume ingesting gluten. And that remains to be seen, but that's the hope," Miller says. Miller also hopes to expand his research to other diseases like asthma and allergies. His team has successfully induced tolerance of myelin in multiple sclerosis models, and insulin in type 1 diabetes models. But the celiac trial is the first clinical trial showing the technology works in real, human patients. The nanotechnology is still years away from being approved to treat particular conditions in humans, but Miller is thrilled with results so far. The future of treating allergies and autoimmune disease may be individualised, he says. "As our knowledge of autoimmune and allergic diseases is enhanced and we understand more and more of the targets that are involved in many of these autoimmune or allergic disease processes, we should be able to have really personalised therapy based on the genetics of a particular individual," Miller says. It turns out good things do come in small packages.

Inverse, 24 October 2019

<http://www.inverse.com>

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Cleaning up air pollution may have a surprisingly low-tech fix

2019-11-12

Dealing with the air pollution that plagues cities across the United States doesn't necessarily require fancy, expensive technology, new research suggests. Instead it may be easier, cheaper, and more effective to simply let nature do the work. Restoring plant life on unused land in counties across the US could suck up 27 percent more air pollution than current rates, according to a study in the journal *American Chemical Society*. This strategy comes with a far lower price tag than technological fixes for most regions of the country, the authors report. "In many situations, vegetation can provide a solution for cleaning up air that's economically more attractive, and also environmentally and socially more attractive, than technology," lead author and Ohio State University professor Bhavik Bakshi, Ph.D., tells *Inverse*. Bakshi's team looked at sulfur dioxide, particulate matter, and nitrogen dioxide. These pollutants have been linked to high asthma rates and fertility issues in women, among other health problems. When it comes to air pollution, urban areas may benefit the most from restoring unused land to vegetation, according to a new study. The researchers studied individual counties across nine climatic regions in the US, measuring benefits of restoring "available" land, or places not being used for farming or buildings, to whatever was the most common type of vegetation found in the county. They also measured how ecological restoration could benefit urban versus rural populations. In rural areas, about 19 percent of the population would benefit from restoration, compared with 74 percent in urban areas, the researchers found. "Population density is much higher in regions where there is not as much vegetation to take up the emissions," Bakshi says. The vast majority of people in the US — between 74 and 98 percent — live in areas where their greenery absorbs less than half of the emissions released. So, there's plenty of room for improvement. But even in places where the amount of air pollution taken in by plants is close to the region's total emissions, pollution still has an impact. That comes down to the time delay between emissions entering the atmosphere and being absorbed by vegetation. Vegetation is not going to be able to eliminate pollution, but it can be a part of the solution. Bakshi compares it to filling a bathtub. As you pour water into the tub, you can start to bail it out. But lowering the water's volume doesn't change its initial impacts. "Just because you're removing water from it doesn't mean that the bathtub will not get wet at all," Bakshi says. The findings suggest that the key is to use both technology and ecosystem restoration to combat air pollution at the source, coming up

Restoring natural areas could have big benefits for human health.

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with “a proper combination of the two.” Policies to reduce air pollution in the US have generally focused on technology, but they can only take us so far, Bakshi says. “Vegetation is not going to be able to eliminate pollution, but it can be a part of the solution,” he says. “It needs to be basically integrated with technology.” The benefits of restoring natural areas may extend beyond the scope of the study, according to the researchers. Cleaner air means reduced respiratory health problems, better visibility, and “other recreational benefits which are currently underestimated in this study,” they write. Recognising the wider benefits of healthy ecosystems for humans can help improve upon the successful engineering and policy efforts of the past, Bakshi says. “The paradigm needs to shift towards including specifically what ecosystems are doing for us.”

Inverse, 6 November 2019

<http://www.inverse.com>

“Unsinkable metal” stays afloat even with holes punched in it

2019-11-12

Superhydrophobic materials, which are excellent at repelling water, can be extremely useful for a whole range of reasons, both obvious and not-so-obvious. They can prevent ice from building up on surfaces, make electronics waterproof, make ships more efficient or keep people from peeing in public. Now engineers have found a quirky new use for superhydrophobic materials – making “unsinkable” metals that stay floating even when punctured. Superhydrophobic materials get their water-repelling properties by trapping air in complex surfaces. These air bubbles make it hard for water to stick, so droplets instead bounce or roll right off. But, of course, air also makes things buoyant, so the team set out to test how superhydrophobic materials could be used to make objects that float better. The researchers used ultra-fast laser pulses to etch microscale and nanoscale patterns onto the surfaces. That traps large volumes of air, making the metals both superhydrophobic and buoyant. But the problem was that these complex surfaces would eventually wear away due to friction in the water, reducing the effectiveness of both of those properties. So, the researchers came up with a creative solution. They built structures made up of two treated aluminium surfaces facing each other, connected by a small central pole. The distance between the two plates was carefully chosen to trap the maximum amount of air, like a waterproof compartment in the middle. The end result is virtually unsinkable, the team says. After being weighed down for two months, the

An “unsinkable” metal floats on top of water, thanks to being superhydrophobic

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structures jumped back to the surface as soon as the load was removed. Even damaging the surfaces didn't make them sink – the team drilled six holes in them measuring 3 mm, and one measuring 6 mm, and the structures stayed afloat. Apparently, enough air remains trapped in other parts of the structure. The researchers say that the etching technique could be used on basically any metal or other material, and the resulting unsinkable devices could have a range of potential applications. Ships and flotation devices could stay afloat even after sustaining heavy damage, and electronic monitoring devices could keep running for long periods underwater. The work was conducted by scientists at the University of Rochester and the Changchun Institute of Optics, Fine Mechanics, and Physics in China. The research was published in the journal ACS Applied Materials and Interfaces.

New Atlas, 6 November 2019

<http://newatlas.com>

MIT Researchers Have Created Tiny Cube Robots That Swarm Together With a Hive Mind

2019-11-12

It's the closest thing we've seen to real-life Transformers: robotic blocks that can travel independently, attach themselves to each other in predefined structures, follow paths and light sources, and more. MIT researchers just released video footage of these new M-Blocks 2.0 cubes in action, and we can't stop watching. They can shuffle themselves into order, climb up on top of each other, spin in mid-air, and engage in several more types of hive-like behaviour. This swarming coordination is the big step forward in this latest batch of bots. Each cube houses a flywheel spinning at 20,000 revolutions per minute, while on the outside are barcodes and magnets to help the cubes recognise and attach to each other. Pre-programmed algorithms tell the blocks what they're supposed to do and how they should be interacting with each other. "M stands for motion, magnet, and magic," says computer scientist Daniela Rus, director of the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT. "'Motion', because the cubes can move by jumping. 'Magnet', because the cubes can connect to other cubes using magnets, and once connected they can move together and connect to assemble structures. 'Magic', because we don't see any moving parts, and the cube appears to be driven by magic." While the M-Blocks 2.0 might remind us of the Transformer movies, these cubes could actually have some seriously useful applications – building bridges and staircases to rescue stranded people

It's the closest thing we've seen to real-life Transformers: robotic blocks that can travel independently, attach themselves to each other in predefined structures, follow paths and light sources, and more.

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after natural disasters hit. According to the researchers, scaling up the number of cubes should be relatively straightforward, too. A paper on the M-Blocks 2.0 cubes is being presented at the IEEE International Conference on Intelligent Robots and Systems in November in Macau.

Watch video here: [Video](#)

Science Alert, 9 November 2019

<http://www.sciencealert.com.au>

Here's how we can stop a mountain of electric car batteries piling up

2019-11-12

More than a million electric cars were bought globally in the first half of this year, the same number sold across the whole of 2017. In the UK, sales of pure electric cars were up 151 per cent last month. Such signs of rapid growth are good news for air quality and climate change, but research out today warns of a potential sting in the tail. There is no such thing as an electric car battery waste mountain, yet. However, the number of cars set to be sold globally this year could one day lead to more than 500,000 tonnes of battery waste, five times that of all the portable batteries recycled in the European Union annually. Those lithium-ion car batteries will need to be recycled or pose an environmental and safety risk, according to Laura Driscoll at the University of Birmingham, UK, and her colleagues. Whether that translates into a challenge or opportunity depends on what carmakers and governments do next. "It's a challenge because most current generation batteries aren't designed for recycling," says Driscoll. For example, Tesla's high-end cars use packs of cylindrical battery cells, which in some cases are bonded into a battery module, making them hard to remove and recycle – though the company says it is working to improve this. Nissan's Leaf model, by contrast, uses a pouch of rectangular cells which are easier to open and separate for recycling. There is no standardisation among car makers on battery packs, and little sign of any coming soon. "If the battery packs were more of a standard design, it would make the process at end-of-life much easier," says Driscoll. Most electric car batteries should have a lifetime of around 15 to 20 years. While their first decade will probably be in a car, some have already gone on to a second life as Tesla Powerwall-style batteries in homes, and more will follow. Still, eventually they will need to be recycled. Although dumping electric car batteries in landfill, where they can leach toxic materials, is illegal, there is a question mark over whether recycling facilities can scale

More than a million electric cars were bought globally in the first half of this year, the same number sold across the whole of 2017.

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up fast enough. "In Europe there are 18 companies looking at lithium-ion recycling, but they all recycle different material, so capacity is definitely an issue," says Gloria Esposito of the Low Carbon Vehicle Partnership. Driscoll says it would be "environmentally disastrous" if there isn't a strategy for dealing with the batteries. What's more, stockpiling old batteries poses fire risks. Another concern is batteries being exported to a country like India for a legitimate second use, such as powering a microgrid, but where no recycling facilities exist when they are spent. "That could be a growing time bomb, especially if things take off quickly," says Jonathan Radcliffe at the University of Birmingham, who wasn't involved in the research. As well as the environmental benefits of mining fewer raw materials, recycling would bring an economic opportunity for reclaiming metals from batteries, says Driscoll. Cobalt, nickel and manganese are three of the most valuable to recover from them. The success of recycling will depend partly on automation, as robots can do the job cheaper, faster and safer than humans, say Driscoll and colleagues. Which brings us back to carmakers: if they made battery packs in a more standardised way, or used something a machine could read, such as a QR code, that would aid automation. "[Carmakers] are a bit conflicted because they want a competitive advantage, to make the batteries as cheap and high-performance as they can. That might not always align with making them in a certain set of standards," says Radcliffe. That is why regulation will be key to manufacturers' decisions and, in turn, how easily we can tackle that future battery waste mountain.

New Scientist, 6 November 2019

<http://www.newscientist.com/>

Go with the flow: Scientists design new grid batteries for renewable energy

2019-11-12

How do you store renewable energy so it's there when you need it, even when the sun isn't shining or the wind isn't blowing? Giant batteries designed for the electrical grid -- called flow batteries, which store electricity in tanks of liquid electrolyte -- could be the answer, but so far utilities have yet to find a cost-effective battery that can reliably power thousands of homes throughout a lifecycle of 10 to 20 years. Now, a battery membrane technology developed by researchers at the U.S. Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) may point to a solution. As reported in the journal of Joule, the researchers developed a versatile yet affordable battery membrane -- from

Scientists have designed an affordable 'flow battery' membrane that could accelerate renewable energy for the electrical grid.

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a class of polymers known as AquaPIMs. This class of polymers makes long-lasting and low-cost grid batteries possible based solely on readily available materials such as zinc, iron, and water. The team also developed a simple model showing how different battery membranes impact the lifetime of the battery, which is expected to accelerate early stage R&D for flow-battery technologies, particularly in the search for a suitable membrane for different battery chemistries. "Our AquaPIM membrane technology is well-positioned to accelerate the path to market for flow batteries that use scalable, low-cost, water-based chemistries," said Brett Helms, a principal investigator in the Joint Centre for Energy Storage Research (JCESR) and staff scientist at Berkeley Lab's Molecular Foundry who led the study. "By using our technology and accompanying empirical models for battery performance and lifetime, other researchers will be able to quickly evaluate the readiness of each component that goes into the battery, from the membrane to the charge-storing materials. This should save time and resources for researchers and product developers alike." Most grid battery chemistries have highly alkaline (or basic) electrodes -- a positively charged cathode on one side, and a negatively charged anode on the other side. But current state-of-the-art membranes are designed for acidic chemistries, such as the fluorinated membranes found in fuel cells, but not for alkaline flow batteries. (In chemistry, pH is a measure of the hydrogen ion concentration of a solution. Pure water has a pH of 7 and is considered neutral. Acidic solutions have a high concentration of hydrogen ions, and are described as having a low pH, or a pH below 7. On the other hand, alkaline solutions have low concentrations of hydrogen ions and therefore have a high pH, or a pH above 7. In alkaline batteries, the pH can be as high as 14 or 15.) Fluorinated polymer membranes are also expensive. According to Helms, they can make up 15% to 20% of the battery's cost, which can run in the range of \$300/kWh. One way to drive down the cost of flow batteries is to eliminate the fluorinated polymer membranes altogether and come up with a high-performing yet cheaper alternative such as AquaPIMs, said Miranda Baran, a graduate student researcher in Helms' research group and the study's lead author. Baran is also a Ph.D. student in the Department of Chemistry at UC Berkeley.

Getting back to basics

Helms and co-authors discovered the AquaPIM technology -- which stands for "aqueous-compatible polymers of intrinsic microporosity" -- while developing polymer membranes for aqueous alkaline (or basic) systems as part of a collaboration with co-author Yet-Ming Chiang, a principal investigator in JCESR and Kyocera Professor of Materials Science

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and Engineering at the Massachusetts Institute of Technology (MIT). Through these early experiments, the researchers learned that membranes modified with an exotic chemical called an “amidoxime” allowed ions to quickly travel between the anode and cathode. Later, while evaluating AquaPIM membrane performance and compatibility with different grid battery chemistries -- for example, one experimental setup used zinc as the anode and an iron-based compound as the cathode -- the researchers discovered that AquaPIM membranes lead to remarkably stable alkaline cells. In addition, they found that the AquaPIM prototypes retained the integrity of the charge-storing materials in the cathode as well as in the anode. When the researchers characterised the membranes at Berkeley Lab’s Advanced Light Source (ALS), the researchers found that these characteristics were universal across AquaPIM variants. Baran and her collaborators then tested how an AquaPIM membrane would perform with an aqueous alkaline electrolyte. In this experiment, they discovered that under alkaline conditions, polymer-bound amidoximes are stable -- a surprising result considering that organic materials are not typically stable at high pH. Such stability prevented the AquaPIM membrane pores from collapsing, thus allowing them to stay conductive without any loss in performance over time, whereas the pores of a commercial fluoro-polymer membrane collapsed as expected, to the detriment of its ion transport properties, Helms explained. This behaviour was further corroborated with theoretical studies by Artem Baskin, a postdoctoral researcher working with David Prendergast, who is the acting director of Berkeley Lab’s Molecular Foundry and a principal investigator in JCESR along with Chiang and Helms. Baskin simulated structures of AquaPIM membranes using computational resources at Berkeley Lab’s National Energy Research Scientific Computing Centre (NERSC) and found that the structure of the polymers making up the membrane were significantly resistant to pore collapse under highly basic conditions in alkaline electrolytes.

A screen test for better batteries

While evaluating AquaPIM membrane performance and compatibility with different grid battery chemistries, the researchers developed a model that tied the performance of the battery to the performance of various membranes. This model could predict the lifetime and efficiency of a flow battery without having to build an entire device. They also showed that similar models could be applied to other battery chemistries and their membranes. “Typically, you’d have to wait weeks if not months to figure out how long a battery will last after assembling the entire cell. By using a simple and quick membrane screen, you could cut that down to a few

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hours or days," Helms said. The researchers next plan to apply AquaPIM membranes across a broader scope of aqueous flow battery chemistries, from metals and inorganics to organics and polymers. They also anticipate that these membranes are compatible with other aqueous alkaline zinc batteries, including batteries that use either oxygen, manganese oxide, or metal-organic frameworks as the cathode. Researchers from Berkeley Lab, UC Berkeley, Massachusetts Institute of Technology, and Istituto Italiano di Tecnologia participated in the study.

Science Daily, 7 November 2019

<http://www.sciencedaily.com>

Microbes harvest electrons: Novel process discovered

2019-11-12

Ever since scientists discovered that certain microbes can get their energy from electrical charges, researchers have wondered how they do it. Bacteria don't have mouths, so they need another way to bring their fuel into their bodies. New research from Washington University in St. Louis reveals how one such bacteria pulls in electrons straight from an electrode source. The work from the laboratory of Arpita Bose, assistant professor of biology in Arts & Sciences, was published 5 November in the scientific journal *mBio*. "The molecular underpinning of this process has been difficult to unravel until our work," Bose said. "This is mostly due to the complex nature of the proteins involved in this process. But now, for the first time, we understand how phototrophic microbes can accept electrons from solid and soluble substances." Dinesh Gupta, a PhD candidate in the Bose laboratory, is the first author on this new study. "I was excited when we found that these phototrophic bacteria use a novel processing step to regulate the production of key electron transfer protein involved in this process," Gupta said. "This study will aid in designing a bacterial platform where bacteria can feed on electricity and carbon dioxide to produce value-added compounds such as biofuels." Getting the electricity across the outer layer of the bacteria is the key challenge. This barrier is both nonconductive and impermeable to insoluble iron minerals and/or electrodes. Bose and her collaborators, including Robert Kranz, professor of biology, showed that the naturally occurring strain of *Rhodospseudomonas palustris* TIE-1 builds a conduit to accept electrons across its outer membrane. The bacteria relies on an iron-containing helper molecule called a deca-heme cytochrome *c*. By processing this protein, TIE-1 can form an essential bridge to its electron source. Extracellular electron uptake, or EEU, can help microbes to survive

New work reveals how one kind of bacteria 'eats' electricity by pulling in electrons straight from an electrode source.

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under nutrient-scarce conditions. Now that Bose has documented these mechanisms behind EEU, she hopes to use it as a biological marker to identify other electricity-eating bacteria in the wild. The findings will help researchers to understand the importance of this functionality in metabolic evolution and microbial ecology.

Science Daily, 5 November 2019

<http://www.sciencedaily.com>

Invention of teeny-tiny organic films could enable new electronics

2019-11-12

The first cell phone, released in 1983, was the size of a brick and weighed two-and-a-half pounds. The newest Apple Watch, released this fall, weighs 1.1 ounces. These kinds of technological leaps have been made possible by finding new and inventive ways of combining materials, which can pack more information and circuitry into smaller and smaller packages. In a first, scientists at the University of Chicago, in collaboration with researchers at Cornell University and Argonne National Laboratory, have discovered an easy, efficient way to grow extremely thin films of organic materials. The findings, published Nov. 7 in *Science*, could be a stepping-stone to future electronics or technologies with new abilities. Scientists have known for a long time how to make extremely thin layers—down to a few atoms thick—out of inorganic materials. That's how cell phones have shrunk in size and solar panels have sprung up on roofs around the world. But duplicating that manufacturing process with materials that are organic (in the chemical sense, that is, something containing carbon) has been tricky. "If you can make materials into atomically thin layers, you can stack them into sequences and get new functions, and there are some great reasons to think organic films could be really useful," said Yu Zhong, a postdoctoral researcher and co-first author on the paper. "But until now it's been very challenging to control the thickness of the film, and to make them in large quantities." Luckily, chemistry and molecular engineering professor Jiwoong Park is an expert in pioneering new ways to make ultra-thin films—whether it's sewing together crystalline sheets or stacking films like Post-Its. In this case, the team took its inspiration from the stubborn separation that happens when you mix two liquids that don't mix, like oil and water. In essence, they used the line that forms between them like a mould to create a perfect thin, flat film. They fill a reactor halfway with liquid A, then add liquid B. At the line where the two meet, they use a tiny tube to inject the rest of the ingredients, which

Scientists discovered a new method to join thousands of organic molecules into a smooth flat film only a few nanometres thick.

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assemble into a film. Then scientists evaporate or drain the liquids, and the film gently glides down to rest intact. "If you think about it like cloth, to date, people have only been able to make patches—and these are gigantic rolls of fabric," Park said. Notably, the film grows in one continuous motion, so there are no awkward joints between patches. Additionally, it can be performed at room temperature, a much more efficient procedure than the extremely high temperatures usually needed to manufacture inorganic films. The method also provides an innovative way to combine organic and inorganic layers. "Inorganic and organic materials have different strengths and weaknesses that could complement each other, but the conditions to grow them are so different that it's been a challenge to make them get along," said graduate student Baouri Cheng, the paper's other co-first author. In this method, though, "put an inorganic substrate on the floor of the reactor, and now you have a beautiful sandwich," Park said. They tested how the films work as electrical capacitors, and found good performance—a heartening sign for electronics. But the team has many more ideas: nanorobots, a fabric that bends or straightens when exposed to water or light, membranes to filter water or boost batteries, sensors that detect toxins, and even bits for quantum computers of the future. "This is really a demonstration of a general platform to integrate polymers," Zhong said. "We can see a multitude of uses and opportunities, and we're already investigating some of them." UChicago postdoctoral researchers Chibeom Park, Andrew Mannix, Jae-Ung Lee, Joonki Suh and Kibum Kang and graduate students Fauzia Mujid, Sarah Brown and Kan-Heng Lee were also co-authors on the study, as well as Steven Sibener, the Carl William Eisendrath Distinguished Service Professor of Chemistry at UChicago; Professor David Muller and graduate student Ariana Ray at Cornell University; and Argonne National Laboratory scientist Hua Zhou. The team used the University of Chicago Pritzker Nanofabrication Facility and Materials Research Science and Engineering Centre, as well as the Advanced Photon Source at Argonne National Laboratory. Park is currently working with the Polsky Centre for Entrepreneurship and Innovation at the University of Chicago to advance the discovery.

Phys.org, 8 November 2019

<http://phys.org>

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Scientists take strides towards entirely renewable energy

2019-11-12

Scientists from Trinity College Dublin have taken a giant stride towards solving a riddle that would provide the world with entirely renewable, clean energy from which water would be the only waste product. Reducing humanity's carbon dioxide (CO₂) emissions is arguably the greatest challenge facing 21st century civilisation—especially given the ever-increasing global population and the heightened energy demands that come with it. One beacon of hope is the idea that we could use renewable electricity to split water (H₂O) to produce energy-rich hydrogen (H₂), which could then be stored and used in fuel cells. This is an especially interesting prospect in a situation where wind and solar energy sources produce electricity to split water, as this would allow us to store energy for use when those renewable sources are not available. The essential problem, however, is that water is very stable and requires a great deal of energy to break up. A particularly major hurdle to clear is the energy or “overpotential” associated with the production of oxygen, which is the bottleneck reaction in splitting water to produce H₂. Although certain elements are effective at splitting water, such as Ruthenium or Iridium (two of the so-called noble metals of the periodic table), these are prohibitively expensive for commercialisation. Other, cheaper options tend to suffer in terms of their efficiency and/or their robustness. In fact, at present, nobody has discovered catalysts that are cost-effective, highly active and robust for significant periods of time. So, how do you solve such a riddle? Stop before you imagine lab coats, glasses, beakers and funny smells; this work was done entirely through a computer. By bringing together chemists and theoretical physicists, the Trinity team behind the latest breakthrough combined chemistry smarts with very powerful computers to find one of the “holy grails” of catalysis. The team, led by Professor Max García-Melchor, made a crucial discovery when investigating molecules which produce oxygen: Science had been underestimating the activity of some of the more reactive catalysts and, as a result, the dreaded “overpotential” hurdle now seems easier to clear. Furthermore, in refining a long-accepted theoretical model used to predict the efficiency of water splitting catalysts, they have made it immeasurably easier for people (or super-computers) to search for the elusive “green bullet” catalyst. Lead author, Michael Craig, Trinity, is excited to put this insight to use. He said: “We know what we need to optimise now, so it is just a case of finding the right combinations.” The team aims to now use artificial intelligence to put a large number of earth-abundant metals and ligands (which glue them together to

Scientists from Trinity College Dublin have taken a giant stride towards solving a riddle that would provide the world with entirely renewable, clean energy from which water would be the only waste product.

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generate the catalysts) in a melting pot before assessing which of the near-infinite combinations yield the greatest promise. In combination, what once looked like an empty canvas now looks more like a paint-by-numbers as the team has established fundamental principles for the design of ideal catalysts. Professor Max García-Melchor added: "Given the increasingly pressing need to find green energy solutions it is no surprise that scientists have, for some time, been hunting for a magical catalyst that would allow us to split water electrochemically in a cost-effective, reliable way. However, it is no exaggeration to say that before now such a hunt was akin to looking for a needle in a haystack. We are not over the finishing line yet, but we have significantly reduced the size of the haystack and we are convinced that artificial intelligence will help us Hoover up plenty of the remaining hay." He also stressed that: "This research is hugely exciting for a number of reasons and it would be incredible to play a role in making the world a more sustainable place. Additionally, this shows what can happen when researchers from different disciplines come together to apply their expertise to try to solve a problem that affects each and every one of us." Professor Max García-Melchor is an Ussher Assistant Professor in Chemistry at Trinity and senior author on the landmark research that has just been published in a leading international journal, Nature Communications.

Phys.org, 8 November 2019

<http://phys.org>

New polymer releases molecular cargo in response to force

2019-11-12

Caltech scientists have developed a new kind of polymer that can carry a chemical payload as part of its molecular structure and release it in response to mechanical stress. The chemical system they have developed could one day be used to create medical implants that can release drugs into the body when triggered by something like ultrasound waves, they say. In a new paper published in the September 13 issue of the Journal of the American Chemical Society, Assistant Professor of Chemistry Maxwell Robb and researchers in his lab describe the polymer they have developed and the reaction that makes the payload system possible. The new material consists of a set of polymer chains bonded to the payload system, creating a mechanically sensitive unit called a mechanophore. A so-called cascade reaction ejects the payload from the polymer. In simple terms, force applied to the polymer causes weak bonds in the mechanophore to rupture, spitting out an unstable intermediate molecule that promptly

Coumarin dye, the chemical chosen as the molecular payload in this study, fluoresces when exposed to ultraviolet light.

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breaks down to release the attached payload. In their paper, the authors demonstrate the release of a coumarin dye, an organic molecule with useful properties, but they say the polymer could be tailored to release a variety of molecules, including those with therapeutic qualities. A material that can release drugs on command could be used to provide more precise treatment of some medical conditions; for example, a cancer therapy could deliver a drug directly to the intended target. "The generality of this new platform is unique in that it allows, in principle, the mechanically triggered release of a wide range of cargo molecules," Robb says. The system Robb and his colleagues have developed could also be tweaked for other purposes. He says that it is possible to create a polymer that depolymerizes—or completely breaks down into small molecules—when subjected to stress. Alternatively, a polymer could be tailored to release a reporter molecule to signal locations in a structure that are under stress and could lead to a structural failure. "We are actively working on expanding the design in a number of directions, to evaluate the scope of cargo release and for triggered depolymerization, which is particularly promising for stress amplification since it allows a single triggering event to generate many small molecules through a domino reaction," Robb says. The paper is titled "Mechanically Triggered Small Molecule Release from a Masked Furfuryl Carbonate."

Phys.org, 8 November 2019

<http://phys.org>

\$10 'Intelligent' Material Could Make MRI Faster

2019-11-12

A new, "intelligent" metamaterial—which costs less than ten bucks to build—could make the entire magnetic resonance imaging process faster, safer, and more accessible to patients around the world. Clinicians use MRI to diagnose medical problems by spotting abnormalities that could indicate anything from a torn meniscus to muscular dystrophy. But MRIs are expensive, expose patients to radiation, and they take a long time—often the greater part of an hour for a single scan. Finding enough MRI time for waiting patients can be a problem, even in US hospitals, but in hospitals in countries like India, waiting periods of a year or more can put patients' lives at risk. So how do we speed up the MRI process without jeopardizing the quality of imaging? To solve the problem, researchers are getting creative with metamaterials. The research appears in *Advanced Materials*.

"Shortening MRI examinations is paramount to maximising the capacity," says Stephan Anderson.

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How Does MRI Work?

MRI works by generating a powerful magnetic field and sending radio waves into a patient's body. "An MRI's magnetic field is many thousands of times stronger than the Earth's magnetic field," says Xiaoguang Zhao, an assistant research professor of radiology at Boston University's School of Medicine. "A precisely orchestrated series of higher-energy radio waves are sent into the human body, and the tissues emit lower-energy radio waves that are received by the MRI to produce an image." The quality of MRI images depends to a great extent on what's called "signal-to-noise ratio," or SNR. The higher the SNR, the better the image, and the most direct way to improve the SNR is to turn up the magnetic field. Unfortunately, any increase in the magnetic field also increases complexity and cost of the MRI, as well as potential risks to patients, whose tissue, and particularly, whose implanted medical devices, the radiation literally heats up. For that reason, radiologists who would like to get a better look inside a body cannot simply turn up the magnetic field strength. So, Xin Zhang, a professor of mechanical engineering at the College of Engineering and a professor in the Photonics Centre, and her collaborators developed a new magnetic metamaterial that, when placed beside the body part that is the target of a scan, boosts the energy the patient's body emits, increasing SNR and improving MRI imaging. A paper on the magnetic metamaterial, which researchers made of simple copper wiring and plastic, was published in *Communications Physics*. Now, the researchers have taken their development one big step further, developing what they call an "intelligent" metamaterial that selectively boosts the low-energy emissions from the patient's body, and literally turns itself off during the millisecond bursts of high-energy transmission from the machine.

Safer, Faster, Crisper

Zhang says that the intelligent metamaterial amplifies SNR by 10-fold, which greatly enhances image quality and reduces scan time, opening up a new way to obtain crisper MRI images at very low cost. "Shortening MRI examinations is paramount to maximising the capacity," says Stephan Anderson, a radiologist at Boston Medical Centre and professor of radiology at the School of Medicine. "Not to mention revenue, as well as the overall patient experience of this powerful imaging technology." "The intelligent metamaterial consists of an array of metallic helical resonators closely packed with [a passive sensor]," says Zhao. "When the high-energy radio waves are coming in, the metamaterial detects the high energy level and 'turns off' the resonance automatically. With low-energy radio excitation, the metamaterial [turns on] the resonance and enhances

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the magnetic component of the radio wave." That off-time, while only milliseconds long, allows clinicians to use the intelligent metamaterial to enhance the energy sent back to the MRI. It also diminishes the patient's overall exposure to radio wave radiation and mitigates potential safety concerns, easing the path toward adoption of this technology in clinical imaging. "We can now build smart materials that can interact with radio waves intelligently, enhancing the wanted signal while letting the unwanted signal go," says Zhang. The researchers estimate that the metamaterial array should cost less than \$10 to construct. Even though the current magnetic metamaterial prototype is a flat, thick layer, they expect to adapt it to a flexible, ultra-thin MRI enhancement sheet. Integrated with clinical MRI systems, they say, their newly discovered magnetic metamaterials have the potential to usher in a quantum leap in the performance of MRI. Support for the work came from the National Institute of Biomedical Imaging and Bioengineering.

Futurity, 7 November 2019

<http://www.futurity.org>

This Start-up Is Aging Red Wine on the International Space Station

2019-11-12

An unusual payload launched for the International Space Station this weekend. Among the 8,200 pounds of research, crew supplies, and hardware contained in a Northrup Grumman resupply rocket, there were also twelve bottles of wine, as pointed out by TechCrunch. Sadly, the wine isn't meant for astronaut consumption. The twelve ISS-bound bottles of an undisclosed varietal are the work of French start-up Space Cargo Unlimited, which gave the mission the whimsical Latin name "Vitis Vinum in Spatium Experimentia," which translates roughly to "Wine Grape in Space Experiment." The project is meant to study the effects of microgravity and space radiation on the aging process of wine. For the next twelve months, the wine will remain on the ISS, sealed in its glass bottles, while samples from the batch age simultaneously back on Earth. After the space wine returns to Earth, the researchers will analyse both samples to determine how space aging affects the fermentation process of wine, including a bit of taste testing to see how flavours may have changed. According to Space Cargo Unlimited's website, the mission is "the first privately lead comprehensive research program on the ISS" to focus "on the future of agriculture for a changing Earth." But it isn't the first-time fermented beverages have left the launchpad. In fact, both beer

An unusual payload launched for the International Space Station this weekend.

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and whisky have both made space debuts. There was once even a time when Russian cosmonauts tipped cognac on the since-decommissioned space station Mir — at the request of doctors who claimed, dubiously, that it might have health benefits. The Space Cargo project will hopefully produce insights into space fermentation, but may also represent a first tentative step toward establishing space-based commerce. That's because of the start-up's business model which, as reported by Quartz, involves a system in which "the research will be paid for in part by a luxury goods partnership that will deliver a customised chest full of objects flown to space to ultra-wealthy sponsors, called patrons, who back the project. The highlight of that chest will be a bottle of the wine." Such a plan, though gimmicky, isn't entirely farfetched. In a climate where NASA's budget is facing ever-tighter restrictions, the future may depend more on space PR stunts, such as this one. But hey, if that's what it takes to put space-aged Cab Sauv on the wine list, we'll drink.

Futurism, 4 November 2019

<https://futurism.com>

Carbon dioxide capture and use could become big business

2019-11-12

Capturing carbon dioxide and turning it into commercial products, such as fuels or construction materials, could become a new global industry, according to a study by researchers from UCLA, the University of Oxford and five other institutions. Should that happen, the phenomenon would help the environment by reducing greenhouse gas emissions. The research, published in *Nature*, is the most comprehensive study to date investigating the potential future scale and cost of 10 different ways to use carbon dioxide, including in fuels and chemicals, plastics, building materials, soil management and forestry. The study considered processes using carbon dioxide captured from waste gases that are produced by burning fossil fuels or from the atmosphere by an industrial process. And in a step beyond most previous research on the subject, the authors also considered processes that use carbon dioxide captured biologically by photosynthesis. The research found that on average each utilisation pathway could use around 0.5 gigatonnes of carbon dioxide per year that would otherwise escape into the atmosphere. (A tonne, or metric ton, is equivalent to 1,000 kilograms, and a gigatonne is 1 billion tonnes, or about 1.1 billion U.S. tons.) A top-end scenario could see more than 10 gigatonnes of carbon dioxide a year used, at a theoretical cost of under

Capturing carbon dioxide and turning it into commercial products, such as fuels or construction materials, could become a new global industry, according to a new study.

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\$100 per tonne of carbon dioxide. The researchers noted, however, that the potential scales and costs of using carbon dioxide varied substantially across sectors. "The analysis we presented makes clear that carbon dioxide utilization can be part of the solution to combat climate change, but only if those with the power to make decisions at every level of government and finance commit to changing policies and providing market incentives across multiple sectors," said Emily Carter, a distinguished professor of chemical and biomolecular engineering at the UCLA Samueli School of Engineering and a co-author of the paper. "The urgency is huge and we have little time left to effect change." According to the Intergovernmental Panel on Climate Change, keeping global warming to 1.5 degrees Celsius over the rest of the 21st century will require the removal of carbon dioxide from the atmosphere on the order of 100 to 1,000 gigatonnes of carbon dioxide. Currently, fossil carbon dioxide emissions are increasing by over 1% annually, reaching a record high of 37 gigatonnes of carbon dioxide in 2018. "Greenhouse gas removal is essential to achieve net zero carbon emissions and stabilise the climate," said Cameron Hepburn, one of the study's lead authors, director of Oxford's Smith School of Enterprise and Environment. "We haven't reduced our emissions fast enough, so now we also need to start pulling carbon dioxide out of the atmosphere. Governments and corporations are moving on this, but not quickly enough. "The promise of carbon dioxide utilisation is that it could act as an incentive for carbon dioxide removal and could reduce emissions by displacing fossil fuels." Critical to the success of these new technologies as mitigation strategies will be a careful analysis of their overall impact on the climate. Some are likely to be adopted quickly simply because of their attractive business models. For example, in certain kinds of plastic production, using carbon dioxide as a feedstock is a more profitable and environmentally cleaner production process than using conventional hydrocarbons, and it can displace up to three times as much carbon dioxide as it uses. Biological uses might also present opportunities to reap co-benefits. In other areas, utilisation could provide a "better choice" alternative during the global decarbonisation process. One example might be the use of fuels derived from carbon dioxide, which could find a role in sectors that are harder to decarbonise, such as aviation. The authors stressed that there is no "magic bullet" approach. "I would start by incentivising the most obvious solutions -- most of which already exist -- that can act at the gigatonne scale in agriculture, forestry and construction," said Carter, who also is UCLA's executive vice chancellor and provost, and the Gerhard R. Andlinger Professor in Energy and Environment Emeritus at Princeton University. "At the same time, I would aggressively invest in R&D across academia, industry and government

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labs -- much more so than is being done in the U.S., especially compared to China -- in higher-tech solutions to capture and convert carbon dioxide to useful products that can be developed alongside solutions that already exist in agriculture, forestry and construction."

Science Daily, 7 November 2019

<http://www.sciencedaily.com>

New photonic liquid crystals could lead to next-generation displays

2019-11-12

A new technique to change the structure of liquid crystals could lead to the development of fast-responding liquid crystals suitable for next generation displays—3-D, augmented and virtual reality—and advanced photonic applications such as mirrorless lasers, bio-sensors and fast/slow light generation, according to an international team of researchers from Penn State, the Air Force Research Laboratory and the National Sun Yat-sen University, Taiwan. "The liquid crystals we are working with are called blue-phase liquid crystals," said Iam Choon Khoo, the William E. Leonhard Professor of Electrical Engineering, who is the corresponding author for this article. "The most important thing about this research is the fundamental understanding of what happens when you apply a field, which has led to the development of Repetitively-Applied Field technique. We believe that this method is almost a universal template that can be used for reconfiguring many similar types of liquid crystals and soft matter." Blue-phase liquid crystals typically self-assemble into a cubic photonic-crystal structure. The researchers believed that by creating other structures they could develop properties not present in the current form. After nearly two years of experimentation, they realised that by applying an intermittent electrical field and allowing the system to relax between applications and to dissipate accumulated heat, they could slowly coax the crystals into stable and field-free orthorhombic and tetragonal structures. The resulting liquid crystals show a photonic band gap that can be tailored to anywhere within the visible spectrum, and possess fast responses necessary for a variety of next-generation displays and advanced photonic applications. The addition of a polymer to the crystals could stabilise them in a wide temperature range, from freezing to nearly boiling-point compared to their typical pristine counterparts that are stable in only a 5-degree range. The polymer scaffold also speeds up the switching response. In the latest research, the team is applying the lessons learned in this study to create new crystal structures and orientations

A new technique to change the structure of liquid crystals could lead to the development of fast-responding liquid crystals suitable for next generation displays—3-D, augmented and virtual reality—and advanced photonic applications such as mirrorless lasers, bio-sensors and fast/slow light generation, according to an international team of researchers from Penn State, the Air Force Research Laboratory and the National Sun Yat-sen University, Taiwan.

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using the electric field from a laser source. The paper, "Reconfiguration of three-dimensional liquid-crystalline photonic crystals by electrostriction," published online this week in Nature Materials.

Phys.org, 7 November 2019

<http://phys.org>

Scientists put the "solve" in "solvent" for lithium-sulfur battery challenge

2019-11-12

Lithium-ion batteries represent the majority of batteries in consumer electronics and electric vehicles. Today, scientists are looking for new chemistries that could improve the energy density and performance of batteries beyond conventional lithium-ion batteries. One type of these batteries, called lithium-sulfur batteries, could offer more energy density and lower cost than the traditional graphite/metal oxide lithium-ion battery. However, its performance is frequently impaired by a parasitic reaction that happens inside the battery that prevents it from cycling as efficiently. Now, in a new study, scientists at the U.S. Department of Energy's Argonne National Laboratory have discovered how a certain class of electrolyte material can reduce the frequency of this reaction, potentially paving the way for more effective lithium-sulfur batteries. When a lithium-sulfur battery is charged, an unavoidable side reaction called lithium polysulfide shuttling frequently occurs. As the battery charges, lithium sulfide is converted to sulfur on the cathode, but some lithium-sulfur compounds that are incompletely oxidised can dissolve from the cathode into the electrolyte—the liquid region of the battery that separates the two electrodes. At this point, the lithium-sulfur compounds can diffuse and become reduced on the anode and oxidize back on the cathode. This process can go over and over again in a way that wastes the battery's charge without putting it to work. "With the polysulfide shuttle, you're getting nothing out of your battery except for heating it up," said Argonne chemist Chi Cheung Su, an author of the study. "In electrochemical terms, it's like trying to fly from New York to Los Angeles, but getting stuck traveling back and forth between Chicago and Denver." A large part of the reason for the initiation of the polysulfides shuttling happens because the polysulfides are able to dissolve readily in an electrolyte containing a solvent mixture of two compounds called dioxolane (DOL) and dimethoxyethane (DME). "There are two problems that we need to solve simultaneously—having low solubility and high conductivity," Su said. "By achieving both, we can bring these batteries

Lithium-ion batteries represent the majority of batteries in consumer electronics and electric vehicles.

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closer to reality." According to Su, the past five years or so have seen the development of a new type of electrolyte material that could address both of these issues. This material, called a hydrofluoroether, or HFE, has a much lower solvating ability while still maintaining generally good conductivity. "The first step for the lithium to get to the anode involves dissolving it in the electrolyte," he said. "Like water is a really good solvent for table salt, DME is a very good solvent for lithium. But with HFEs it's like trying to dissolve salt in gasoline." Although this general property of HFEs have been known for several years, Su and his colleagues have come up with a general way to predict the solvating behaviour and conductivity of this class of molecules. First, they divided them up into three types depending on their chemical structures. In measuring how the electrolytes performed, the researchers noted an important trade-off: those chemistries that showed the lowest solvating behaviour and the least amount of polysulfide shuttling also had lower conductivities. "It goes to show that there's no magic bullet for lithium-sulfur batteries yet, and that we'll still need to continue to find ways to improve the chemistries we have," Su said. A paper based on the research, "A selection rule for hydrofluoroether electrolyte cosolvent: establishing a linear free-energy relationship in lithium-sulfur batteries," appeared in the May 13 issue of *Angewandte Chemie*.

Phys.org, 7 November 2019

<http://phys.org>

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Spray-on gene editing could make genetic modification easy

2019-11-13

Genetically modifying plants could soon be almost as easy as spraying them with water. A new technique that uses DNA attached to nanoparticles could have a wide variety of uses, including changing the properties of crops while they are growing in fields. "It was so straightforward," says Heather Whitney at the University of Bristol in the UK. "It was really surprising how easy it was." Whitney and her team have so far tested their technique on various plants, including wheat, maize, barley and sorghum. They simply used an ordinary plant mister to spray leaves with water containing nanoparticles called carbon dots that were bound to DNA. The DNA, which codes for a fluorescent protein, got into cells in the plants' leaves, prompting them to glow green under UV light. This is a huge advance on conventional methods for inserting DNA into plants, which aren't as easy or widely applicable. But this DNA wasn't incorporated into the cells' genomes, so should break down over time. Whitney and her colleagues then took their technique a step further, using carbon dots bound to DNA coding for the CRISPR machinery used for genome editing. In this way, they were able to permanently edit the genomes of cells in the leaves they sprayed. The results have yet to be confirmed by other groups, but if it works, spray-on gene editing could speed up plant research. It could also lead to new ways of improving and protecting crops, and of turning plants into biofactories capable of making chemicals such as flavourings and pharmaceutical products. "It's amazing," says Ignacio Rubio Somoza at the Centre for Research in Agricultural Genomics in Spain, who now plans to try the method. "I think it's a pretty great advance."

Genetically modifying plants could soon be almost as easy as spraying them with water.

Spray away

At present, the main tool for genetically engineering plants is a microbe called *Agrobacterium*. Researchers use it to insert new bits of DNA into plant genomes, but it only works in some plants and using it outside the laboratory would be impractical and risky. Another approach is to use a "gene gun" to force DNA into plant cells. However, this can damage plants and is difficult to do on a large scale. Many teams are working on better ways of modifying plants. Whitney decided to try using carbon dots created by her colleague Carmen Galan. Carbon dots, discovered in 2004, are ball-like particles of carbon less than 10 nanometres across, which can be attached to other molecules. These carbon dots can form when carbon compounds burn, and occur naturally. "We've found them in coffee, we've found them in soil," says Galan. Galan makes red-fluorescent

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carbon dots for Whitney by heating sugars in a normal microwave oven. Next, she attaches a polymer called polyethylene glycol that attracts DNA molecules electrostatically. When sprayed on leaves, carbon dots get into nearly every cell on the leaf surface, and up to a third of these cells use the added DNA to make new proteins. Experiments by the team show that the carbon dots don't seem to be toxic, and may even boost plant growth.

Safety concerns

So far, the team's attempts to modify egg cells in plant ovaries and stem cells in growing shoots have failed. That is a disadvantage when it comes to creating new varieties of GM plants. However, it would make it safer to apply carbon dots to fields of plants because any modifications wouldn't get passed on to future generations or spread among wild plants. "It's quite an exciting paper," says Markita Landry at the University of California, Berkeley, who recently got DNA into plant cells using carbon nanotubes. Landry's team has to forcibly inject nanotube solution into leaves – spraying alone doesn't work. Whitney's research is at an early stage and many questions remain unanswered, such as how the carbon dots get into cells. "It's such early days. There's so much we don't know," says Whitney. "It might never be optimised to the point where it could be sprayed on fields." Spray-on gene editing could be misused, for instance to make crops toxic. But Whitney points out that anyone who wanted to poison food could do it far more easily in other ways. As for whether spraying carbon dots into the environment could harm animals, more research is needed. Carbon dots can get into mammalian cells growing in a dish, says Galan, but they are mopped up by the immune system if they get into the body.

New Scientist, 1 November 2019

<http://www.newscientist.com/>

Parasites are going extinct in droves – and we should be very worried

2019-11-13

In 1987, officials from the US Fish and Wildlife Service captured all 22 of the world's remaining California condors in a last-ditch effort to save the species. Back at San Diego Wild Animal Park and Los Angeles Zoo, biologists liberally dusted them with an insecticide called carbaryl to remove any parasites. The condors emerged from the blizzard unscathed, and the captive breeding program was so successful that, by 1991, conservationists began returning birds to the wild. The California condor

They cause deadly diseases and brain-wash crickets to leap into ponds, so why are conservationists fighting to save parasites from extinction?

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louse didn't fare so well. With a few shakes of powdery pesticide, the parasite quietly went extinct. Few people noticed and even fewer cared. If saving this iconic bird meant losing a louse, so be it. Such attitudes still prevail. But perhaps not for much longer. While parasites can harm and even kill their hosts, there is also a growing appreciation of their value. Far from being organisms that must be eradicated at any cost, it is emerging that they play important and beneficial roles in ecosystems. They can even keep their hosts healthy. In fact, in a modern parallel to the California condor story, conservationists trying to save an endangered marsupial called the woylie have discovered that parasites can actually help. Despite this, many parasites are themselves endangered and their plight has been almost completely overlooked. Now a group of pioneering biologists aims to change that. They see parasites as an essential component of life on Earth and believe we should be protecting them. There is no doubt that parasites have a bad reputation. For most people, they are synonymous with disease. This reflects our daily interactions with them. We treat our pets for heartworm and ringworm or take precautions for ourselves against hookworm. We douse our crops in torrents of chemicals to prevent parasites from ruining our food. It is almost dogma that parasites are bad, end of story, says Kevin Lafferty at the University of California, Santa Barbara. Even biology textbooks focus on the negative. This is something conservation biologist Liz Nichols discovered as a graduate student. She is currently on sabbatical at the US State Department, but a decade ago while at Columbia University in New York she decided to investigate what students are taught about parasites. Working in the basement of the American Museum of Natural History with fellow postdoc Andrés Gómez, she searched 77 English-language textbooks published between 1970 and 2009 and found that what little was mentioned about parasites portrayed them in a poor light. History reveals the danger of such blanket prejudice against a group of living organisms. Less than a century ago, many countries established programmes to exterminate apex predators, arguing that everyone would be better off if they didn't exist. Wolves were extirpated from most of the continental US, and populations of big cats and bears around the world plunged. "More animals are being eaten from the inside out than the outside in". However, ecosystems lacking top predators weren't the peacenik utopias some had hoped for. Populations of prey animals, from antelope to zebra, exploded and then starved as their food sources ran out. In the 1960s, conservation biologists began a small but forceful movement to reshape how society views carnivores in a bid to return them to their rightful habitat. This quest is succeeding. Nichols saw similarities with parasites. Because they have been portrayed in such a negative way, no one had thought to ask whether they might

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have a beneficial role in the environment. Her own work on dung beetles had told her about nature's interconnectedness, and she believes that conservation biologists have overlooked some of the strongest links in the natural world. Andrew Dobson at Princeton University agrees. "Parasites are as fundamental to an ecosystem as predators are," he says. In nature, parasitism is the most common way to get food, shelter and other resources – so common that parasites far outnumber free-living organisms. For example, the 45,000 known vertebrates are home to more than 75,000 parasites. "There are more animals being eaten from the inside out than the outside in," says Dobson. At least 70 per cent of food-web interactions are between a parasite and its host, says Carrie Cizauskas at the University of California, Berkeley. "Parasites are the glue that holds an ecosystem together." Take the camel cricket. Like many crickets, it can be infected by a parasite called a horsehair worm. After the worm matures in the cricket's body, it needs to reach fresh water to reproduce. Instead of waiting for the cricket to take an accidental bath, the worm compels its host to make a suicidal leap into a stream or pond, where it can then bore a hole and slither into the water. In doing so, the worm provides a crucial delivery service: crickets account for more than half the food eaten by trout in some areas, according to a study by Lafferty and others.

Extinction threat

If parasites are as valuable as other components of ecosystems, they are also as threatened. In 2017, Cizauskas was part of an international team that tried, for the first time, to assess how global warming will affect parasites. Although climate change has been linked with the spread of diseases, the researchers found no indication that pathogenic parasites will be able to increase their ranges. Instead, the evidence points to between 5 and 10 per cent of parasites going extinct by 2070 as a result of climate-related habitat loss alone. Add in the loss of host species and changing environmental conditions, and as many as 30 per cent of parasitic worms are facing extinction within the next half century. The forecast is even worse for parasites such as lice and ticks that live on the outside of their host. For all this, only two animal parasites are listed on the International Union for Conservation of Nature's Red List of Threatened Species: the pygmy hog-sucking louse and the European medicinal leech, and knowledge about the threat facing parasites is woefully lacking. "We have no idea how many parasites we've lost. They're not cute and cuddly, so we're not tracking them," says Skylar Hopkins, an ecologist at Virginia Tech who has become a leading voice in the movement to protect parasites. Nor are scientists sure just how the loss of parasites will

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affect ecosystems as a whole. One small study, however, provides some worrying clues. A clam called the New Zealand cockle lives in many of the nation's mudflats, using its muscular foot to burrow into the ooze. A fluke known as *Curtuteria australis* likes to embed itself in the cockle's foot. If they become heavily infested, cockles lose their ability to hide in the mud and find themselves stranded. Research reveals that mudflats with more parasitised cockles supported a higher level of animal diversity. Organisms living in the sediment are less disturbed by burrowing shellfish. The exposed cockles are rich pickings for shorebirds and fish. And their shells offer a new habitat for barnacles and other aquatic species. By keeping cockle numbers lower and more stable, *C. australis* does a huge service to the ecosystem. As well as disrupting ecosystems, the loss of parasites could even be bad for their hosts. When scientists gave anti-parasitic drugs to Eurasian oystercatchers, they found that treated chicks were more likely to die than untreated ones. The researchers aren't exactly sure why, but they think the lack of parasites may have interfered with the proper functioning of the bird's immune system. Something similar is thought to happen in humans. Known as the hygiene hypothesis, some evidence shows that in our hyper-clean, low-parasite modern world, our immune system isn't trained to deal with the worms and bacteria with which our species evolved. As a result, it overreacts to what should be harmless targets, causing allergies and autoimmune conditions. The presence of parasites helps to redirect the immune system away from the prolonged inflammation indicative of these conditions, says Cizauskas. The growing realisation that there is a positive side to parasites has persuaded some conservationists that we cannot simply ignore such species and focus only on more charismatic animals. Lafferty calls our current attitude "taxonomic chauvinism". It is much easier to get donations to save cuddly pandas and majestic elephants than stink bugs and spiders, and parasites are at the bottom of the list. "But there's an intrinsic value to every species. They're all the result of millions of years of evolution, and they have adaptations that are remarkable," he says. Dobson notes that saving any species means also saving its ecosystem – and you can't save that ecosystem without also saving its parasites. But in the name of conservation, we intentionally kill parasites. The California condor louse isn't an isolated example. Many parasites have co-evolved to live exclusively on a particular host and, in our efforts to save other species including black-footed ferrets and kakapos, we have deliberately driven some of their parasites to extinction. The answer isn't as simple as forgoing anti-parasitic drugs. Although parasites aren't the supervillains portrayed in many biology textbooks, clearly, they aren't always heroes. As we know to our cost, some are deadly. Plasmodium, the parasite that causes malaria, kills millions of people every

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year. So do gastrointestinal parasites such as *Giardia* and *entamoeba*. But we also know that most parasites aren't deadly. However, they are most likely to kill a host that is undernourished and stressed – conditions that a species on the road to extinction often faces. So, conservationists concerned about parasites must tread a fine line, as those trying to help the woylie have discovered.

Good infestations

The number of woylies has plummeted as a result of predation, habitat loss and climate change. Andrew Thompson at Murdoch University, Australia, suspects that these external stressors have somehow altered the marsupial's relationship with its normal parasites, explaining why woylies captured for breeding programs are often besieged by multiple types of parasites, from intestinal worms to itchy ticks and lice. For many veterinarians, the instinct would be to blast them with strong, anti-parasitic drugs to eradicate these invaders. However, Thompson and his fellow conservationists have discovered that the right combination of parasites can actually improve a woylie's chances of survival. Furthermore, they worry that giving captive animals too much anti-parasitic treatment might leave their immune systems ill-equipped to handle the normal range of parasites they encounter if they return to the wild. So, instead of trying to expunge woylie parasites altogether, the team doles out drugs to only the sickest animals, leaving healthier ones to use their own immune system to keep parasites in check. As a result, the conservationists aren't just working to save one endangered species: a 2017 analysis identified 36 species that called woylies home. Eleven of these, including a previously unknown tick called *Ixodes woyliei*, live exclusively on woylies, and would blink out of existence if their host were to become extinct. The woylie efforts are part of a growing trend among conservationists to be more mindful of parasites. "We're not just crazy nutcases – we want to save the host species, too," says Hopkins. Teams trying to rebuild black-footed ferret populations, for example, are recruiting a single-celled parasite called *Eimeria* to help. Others want to deliberately cultivate parasites in captive Iberian lynxes. Finding the right balance in different situations won't be easy, but if done correctly this new focus on parasite conservation looks like a virtuous cycle. It should help protect their hosts and entire ecosystems, and the parasites. Could this be the beginning of a makeover for some of the world's most despised and misunderstood species? Nichols certainly hopes so. "What we need are children's books about

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parasites, and pillows you sell for far too much money on Etsy," she says. "Parasites are so stinking cool and gross."

New Scientist, 2 November 2019

<http://www.newscientist.com/>

Itchy Skin Conditions And Mental Health Are Linked, And We Need to Talk About It

2019-11-13

Why do we itch? The reasons are many and varied. But what's becoming ever clearer is many who experience chronic itching due to skin conditions also shoulder a profound psychological burden no scratching can relieve. While the nature of this link around conditions like eczema and psoriasis has been investigated before, scientists say we're still only beginning to understand how skin disorders, mental health problems, and quality of life all intersect. "There are already studies showing evidence of a correlation between itch and mental health problems in general, and in specific skin disorders, but there is a lack of a cross-sectional study across chronic skin diseases," says dermatologist Florence J. Dalgard from Lund University in Sweden. To help fill that gap, Dalgard and her team analysed data collected from thousands of dermatology patients with skin issues in 13 European countries, including the UK, France, Germany, Russia, and elsewhere. In total, over 3,500 patients with varying skin diseases took part in the study, undergoing physical examinations and filling out a questionnaire which asked questions about their socio-economic background and experiences with itching, while also measuring symptoms of depression, anxiety, and suicidal ideation. More than 1,300 people without skin conditions acted as a control group, self-reporting the same information. When the research team analysed the responses, they found a number of associations between skin conditions, itching, mood disorders, and quality of life impairments. In patients with skin conditions who reported itching, the prevalence of depression was 14.1 percent. This lowered to 5.7 percent in patients who didn't itch. Controls without skin disorders who reported itching also had around a 6 percent prevalence of depression - while only 3.2 percent in the control group members who didn't have itching reported depression. Anxiety bore a similar pattern, showing up in 21.4 percent of the patients with skin conditions and itching, and dropping to 12.3 percent in patients without itching, while approximately 8 percent of the controls reported anxiety. The prevalence of suicidal ideation was higher in patients with itch (15.7 percent) than in patients without itch (9.1 percent); similarly, it was higher

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in controls with itch (18.6 percent) than controls without (8.6 percent). Patients with itch further reported experiencing more negative life events than the patients without itch did (38.2 percent compared to 32.4 percent respectively), and the patients who experienced itching were also likely to experience more economic problems. While the team acknowledge their data can prove nothing about causation one way or the other (and submit that mental health suffering could potentially induce itch to some degree), they suggest it is much more likely that skin diseases are the cause of itching, which then leads to mental health effects. "Speculative reasons for this correlation are that itch correlates with skin inflammation and skin inflammation induces serotonin network in the brain leading to depression and anxiety," the authors write in their paper. While more research is needed to explore the hypothesis, for now at least, the link between itching and depression looks more firmly established than ever. And that, the researchers say, should be reflected in how we treat patients with skin conditions – with a multidisciplinary team of physicians to help support these people, and everything they may be dealing with. At the same time, preventative programs might be able to play a role in helping to ease itching and maybe reducing the development of the serious psychological symptoms that appear to stem from it. "Our findings demonstrate that the presence of itch in dermatological patients is significantly associated with clinical depression, suicidal ideation and stress," the researchers conclude. "The study reveals that itch contributes substantially to the psychological burden of dermatological patients and confirms the multi-dimensional suffering of dermatological patients with itch." The findings are reported in *Journal of Investigative Dermatology*.

Science Alert, 1 November 2019

<http://www.sciencealert.com.au>

Anti-Vaxxer Claims She Gave Trick-or-Treaters Lollipops Infected With Chicken Pox

2019-11-01

An Australian anti-vaxxer mum has reportedly said she was giving trick-or-treaters chicken pox-tainted lollipops for Halloween, claiming the candies would help give kids the infection that her son has so they can get the chicken pox over with and be immune for life, according to a post shared in a pro-vaccine group called "Light for Riley." On Wednesday the mum, who goes by Sarah Walker RN on Facebook, posted in a private group called "Stop Mandatory Vaccination" that her son recently came down with the chicken pox. She planned to give unwitting trick-or-treaters

An Australian anti-vaxxer mum has reportedly said she was giving trick-or-treaters chicken pox-tainted lollipops for Halloween, claiming the candies would help give kids the infection that her son has so they can get the chicken pox over with and be immune for life, according to a post shared in a pro-vaccine group called "Light for Riley." On Wednesday the mum, who goes by Sarah Walker RN on Facebook, posted in a private group called "Stop Mandatory Vaccination" that her son recently came down with the chicken pox.

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candy tainted with his germs, Yahoo News reported. "So, my beautiful son [redacted] has the chickenpox at the moment and we've both decided to help others with natural immunity this Halloween!" Walker reportedly wrote. "We have the packaging open and closing down pat and can't wait to help others in our community." Insider couldn't verify whether Walker is an actual person who wrote the post seen on "Light for Riley," or whether she truly did pass out chicken pox-infected lollipops. But the tale mimics the concept of chicken pox parties, a trend where parents put their healthy children in the same room as a child who has chicken pox in hopes that the healthy children will contract the disease and "get it over with." The parties were popular before 1995 when a chicken pox vaccine did not yet exist, but there's evidence that these gatherings have made a resurgence in recent years. Chicken pox parties operate on the premise that most people who contract chickenpox once never get it again, but that doesn't make them safe. There is no scientific evidence that getting the infection once will boost a person's immunity and it's also impossible to predict how severe a case of the chicken pox will be, even in a healthy child. Anti-vaxxers often say that getting an infection like the chicken pox or measles, weathering it, and healing is the most natural and effective way to prevent the same infection in the future, but there's no science to back up this claim. It's "incorrect that getting the natural disease is going to make your immunity stronger so you don't need a vaccine, which is a much safer option," paediatrician Dr Natasha Burgert previously told Insider. "People don't realise that the reason we made vaccines is because they can't kill kids." Vaccines contain dead or weakened disease germs and have been proven to boost immune systems safely without exposing people to the airborne form of a disease. Instead of the exposure approach, parents should vaccinate any child who isn't medically exempt. Doing so can help create herd immunity, a concept in which as many people as possible get vaccines in order to protect themselves and other community members who are unable to get vaccines for health reasons, like HIV or cancer. In many cases, herd immunity has stopped the spread of once-rampant diseases like diphtheria and whooping cough. In addition to protecting whole communities, vaccines can protect vulnerable children from potentially severe cases of the chicken pox. It's impossible to know how severe a child's chicken pox bout will be even if they are healthy, Burgert said. In addition to the trademark itchy red rash and blistering chicken pox causes, a minor case of the infection can also lead to headaches, a fever, loss of appetite, and extreme tiredness. In extreme cases, however, an infected person could develop a bacterial infection, pneumonia, brain inflammation, and sepsis, and potentially die, according to the CDC. "Some kids will just get a few [chickenpox], some will die. You just don't know,

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so we vaccinate everyone," they possibly can, Burgert said, adding that people who believe a healthy child can just get the chicken pox over with are gambling with their lives.

Science Alert, 1 November 2019

<http://www.sciencealert.com.au>

J&J says new tests find no asbestos in same baby powder bottle that sparked recall

2019-11-13

Johnson & Johnson has said that 15 new tests found no asbestos in a bottle of baby powder that the U.S. Food and Drug Administration says tested positive for trace amounts of asbestos, a finding the agency stands by. The tests are the latest effort by J&J to prove the safety of its widely used consumer product after a test by the FDA prompted J&J to undertake a nationwide recall of one lot of its Johnson's Baby Powder. FDA officials, in an interview with Reuters, said the agency continues to support the company's voluntary recall. "They would say the product is free of asbestos based on their testing, and we would say the opposite for that sample," said Steve Musser, deputy director for scientific operations in the FDA's Centre for Food Safety and Nutrition. Earlier this month, J&J recalled around 33,000 bottles of baby powder in the United States after the FDA found trace amounts of asbestos in samples taken from a bottle purchased online. "Rigorous and third-party testing confirms there is no asbestos in Johnson's Baby Powder. We stand by the safety of our product," J&J said in a statement. The company did not immediately respond to a request for additional comment on the FDA standing by its test result. The different test outcomes could have resulted from the fact that contaminants are not uniformly dispersed throughout talc and there is no standard test for asbestos in talc, FDA officials said. The voluntary recall was limited to one lot of Johnson's Baby Powder produced and shipped in the United States in 2018, the company said at the time. That move marked the first time the company recalled its iconic baby powder for possible asbestos contamination, and the first time U.S. regulators have announced a finding of asbestos in the product. Asbestos is a known carcinogen that has been linked to deadly mesothelioma. J&J will not reverse the recall of those 22-ounce containers, but its baby powder remains available to consumers in stores, a company spokesman told Reuters. The recall had been the latest blow to the more than 130-year-old U.S. healthcare conglomerate that is facing thousands of lawsuits over a variety of products, including baby powder, opioids, medical devices and the antipsychotic Risperdal.

Johnson & Johnson has said that 15 new tests found no asbestos in a bottle of baby powder that the U.S.

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J&J faces more than 15,000 lawsuits from consumers claiming its talc products, including Johnson's Baby Powder, caused their cancer.

Reuters Health, 29 October 2019

<http://www.reuters.com/news/health>

Asthma carbon footprint 'as big as eating meat'

2019-11-13

Many people with asthma could cut their carbon footprint and help save the environment by switching to "greener" medications, UK researchers say. Making the swap would have as big an "eco" impact as turning vegetarian or becoming an avid recycler, they say. It's because some inhalers release greenhouse gases linked to global warming. But the Cambridge University team told BMJ Open patients must check with a doctor before changing medication. Some patients will not be able to switch and should not be made to feel guilty, they add, and pharmaceutical companies should also look at ways to reduce the carbon footprint of the inhalers they make.

What are greener inhalers?

There are more than five million people with asthma in the UK. The research looked at the environmental impact of different inhaler medications prescribed to patients on the NHS in England. In 2017, about 50 million inhalers were prescribed. Seven out of every 10 of them were metered-dose inhalers - the type that contain greenhouse gases. The gas - hydrofluoroalkane - is used as a propellant to squirt the medicine out of the inhaler.

What difference would it make?

Metered-dose inhalers account for nearly 4% of NHS greenhouse gas emissions, according to experts. The researchers estimate replacing even one in every 10 of these inhalers with a more environmentally friendly type (dry powder inhalers) would reduce carbon dioxide equivalent emissions by 58 kilotonnes. That's similar to the carbon footprint of 180,000 return car journeys from London to Edinburgh, they say. And at the individual level, each metered-dose inhaler replaced by a dry powder inhaler could save the equivalent of between 150kg and 400kg (63 stone) of carbon dioxide a year - similar to the carbon footprint reduction of cutting meat from your diet. Lead researcher Dr Alex Wilkinson said: "The gases within these canisters are such powerful greenhouse gases that they can contribute significantly to an individual's carbon footprint and if you

Many people with asthma could cut their carbon footprint and help save the environment by switching to "greener" medications, UK researchers say.

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are using one or two of these inhalers every month, then that can really add up to hundreds of kilos of carbon dioxide equivalent over the course of a year, which is similar to other actions that people are keen to take to reduce their carbon footprint such as going vegetarian." He said doctors and patients should consider swapping to green alternatives when possible - something the National Institute for Health and Care Excellence also advises.

Is it safe to switch?

People who need to use metered-dose inhalers should absolutely continue to do so, say experts. Switching to a different type of inhaler can be complicated for people with asthma, as it involves learning a new inhaler technique, so it should be done with support from a GP or asthma nurse only, Asthma UK says. NICE has also created a decision aid to help patients make choices. For patients who could not change their medication because it was not clinically advisable, Dr Wilkinson said, there were still ways to be "greener". "It's really important that we use these inhalers wisely, that patients have good technique and they have their technique assessed so we can really make sure every puff counts," he said. "Also, patients should make sure they know how many doses their inhaler contains so they don't waste any. "Once you've finished with your inhaler, it's important to dispose of it properly because they've got greenhouse gases left in them. "Take them back to your pharmacy to be disposed of properly." Asthma UK health advice head Jessica Kirby said: "It is vital that you keep using your inhalers as prescribed. "If you are concerned about the environmental effects, talk to your doctor or asthma nurse at your next annual asthma review, to see whether there is another type of inhaler that would work for you." Simon Stevens, NHS chief executive, said: "The NHS has already cut its carbon footprint by one fifth in the past decade and giving patients the option to, where clinically appropriate, shift to lower carbon 'green' inhalers as set out in the Long Term Plan is not only the right thing for them but also the planet."

BBC News, 30 October 2019

<http://news.bbc.co.uk>

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There's a scientific reason why America's favourite food is pizza

2019-11-13

Pizza is one of the world's most popular foods. In the US, 350 slices are eaten every second, while 40% of Americans eat pizza at least once a week. There's a reason why pizza is so popular. Humans are drawn to foods that are fatty and sweet and rich and complex. Pizza has all of these components. Cheese is fatty, meat toppings tend to be rich, and the sauce is sweet. Pizza toppings are also packed with a compound called glutamate, which can be found in the tomatoes, cheese, pepperoni, and sausage. When glutamate hits our tongues, it tells our brains to get excited — and to crave more of it. This compound actually causes our mouths to water in anticipation of the next bite. Then there are the combinations of ingredients. Cheese and tomato sauce are like a perfect marriage. On their own, they taste pretty good. But according to culinary scientists, they contain flavour compounds that taste even better when eaten together. Another quality of pizza that makes it so delicious: Its ingredients become brown while cooking in the oven. Foods turn brown and crispy when we cook them because of two chemical reactions. The first is called caramelisation, which happens when the sugars in a food become brown. Most foods contain at least some sugar; once foods are between 230 and 320 degrees, their sugars begin to turn brown. Caramel is made from several thousand compounds, making it one of the most complex food products. On a pizza, ingredients like onions and tomatoes become caramelised during baking, making them rich and sweet and flavourful. That brown and crispy crust is also the result of the dough caramelising. While the meat and cheese on your pizza also get brown, this is due to a different process called the "Maillard reaction," which is named after French chemist Louis-Camille Maillard. The Maillard reaction occurs when the amino acids in high-protein foods like cheese and pepperoni react with the sugars in those foods when heated. Pepperonis that become crispy with curled edges, and cheese that browns and bubbles, are examples of the Maillard reaction at work. With bread, cheese, and tomato sauce as its base, pizza might seem like a simple food. It isn't. And now, the next time you're about to devour a slice, you'll be able to appreciate all of the elements of pizza that excite our brains, thrill our taste buds, and cause our mouths to water.

Inverse, 6 November 2019

<http://www.inverse.com>

First analysis of environmental impact of Munich festival reveals extent of emissions

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Oktoberfest 'produces 10 times as much methane as Boston'

2019-11-13

For the millions of people who descend on Munich for the annual bash, Oktoberfest is a celebration of beer, bands and bratwurst. But as the dust settles for another year on the world's largest folk festival, and die Bierleichen ("beer corpses") return to the land of the living, environmental scientists have released the first analysis of methane emissions from the 16-day party. Researchers at Technical University in Munich walked and cycled around the perimeter of the festival last year with mobile sensors aloft. The instruments found the event emitted nearly 1,500kg of methane – 10 times the amount that wafted off Boston, Massachusetts, in the same period. The scientists attributed most of Oktoberfest's emissions to leaks and incomplete combustion in cooking and heating appliances. Though an appreciable part of the rise in the gas, about 10%, was attributed to the flatulence and burps of attendees. Jia Chen, who studies greenhouse gases in urban environments, said: "The observed methane concentrations cannot solely be explained by biogenic sources. "We have strong indications that fossil fuel methane emissions by gas grills and heating appliances are major sources." After carbon dioxide, methane is the second most common greenhouse gas emitted by human activity. Though shorter-lived, it is more effective than carbon dioxide at heating the atmosphere and accounts for about 20% of global heating due to anthropogenic greenhouse gas emissions since 1750. Atmospheric levels of the gas have surged in recent years for reasons scientists cannot fully explain. Having noticed a spike in Munich's methane levels during Oktoberfest in previous years, Chen and her colleagues decided to monitor the event to see whether major festivals made important contributions to greenhouse gas emissions. More than six million people visit Oktoberfest each year and make their way through more than seven million litres of beer, 100,000 litres of wine, half a million chickens and a quarter of a million sausages. To Chen's surprise, on average, every square metre of Oktoberfest in 2018 released 6.7 micrograms of methane per second. Less than 10% was calculated to come from festivalgoers in the form of flatulence and burps, according to a paper submitted to the journal Atmospheric Chemistry and Physics. Chen believes the work can help festival organisers draw up policies to reduce their methane emissions. The study concludes the releases of methane are high enough for major festivals to be considered greenhouse gas sources in local emissions inventories. "Large but time-limited festivals, like Oktoberfest, are sources that have not been accounted for in existing emission

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inventories, even though, as we have seen, the methane emissions are significant," Chen said. "Inaccurate or incomplete emission inventories are a problem, because many decisions are based on this data." With people travelling to Oktoberfest from more than 50 countries, methane leaks from the Theresienwiese site are not the greatest environmental concern. But improving gas appliances to reduce methane emissions still makes sense, Chen said. "Small steps can bring us closer to achieving the world climate goals," she added.

The Guardian, 28 October 2019

<http://www.guardian.com>

Three-story water battery cuts university's energy usage by 40 percent

2019-11-13

The University of the Sunshine Coast (USC) in Queensland, Australia, is on a mission to become completely carbon neutral by 2025, and a huge early addition to its energy systems is boding well for these lofty ambitions. Switched on in September, a new three-story "water battery" is already producing enough juice to power the campus' air conditioning systems, reducing its reliance on the grid by more than 40 percent. In pursuit of its climate-neutral goals, USC teamed up with private company Veolia to draw up a new clean energy solution for its buildings. Looking to make the most of the region's abundant sunshine and take a bite out of the grid energy used for air conditioning, which accounts for 40 percent of its overall usage, the two came up with solution they've dubbed the "water battery." "Air conditioning accounts for 40 percent of our daily energy usage, so by eliminating this we are taking a major step towards our carbon neutral goal," Professor Hill said back in August when the system was first announced. It is in essence a huge thermal energy storage system. It makes use of 6,000 solar panels installed on the campus' rooftops and carparks that make up a 2.1-megawatt photovoltaic system. The energy generated by this solar system is then used to cool 4.5 megalitres of water resting inside a three-story tank. This cooled water is then used for the campus' air conditioning systems, and to great effect. According to Veolia, the system is reducing the carbon footprint of the university by 42 percent. This rapid and dramatic impact has even earned it and the USC team some international acclaim, with the water battery winning the "Out of the Box" category at Iceland's 2019 Global District Energy Climate Awards, announced last week. "The system was switched on in September and is now delivering 2.1 megawatts of power and we

A new energy system for the University of the Sunshine Coast is expected to prevent more than 92,000 tonnes of CO2 emissions over the coming 25 years

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estimate that we will save more than AU\$100 million (US\$69 million) in energy costs over the next 25 years," says USC Chief Operating Officer Dr Scott Snyder. "Another benefit is that we are able to take our students to visit the system and teach them about innovation and finding cleaner energy solutions for the future." Further to these huge cost savings, the system is expected to prevent more than 92,000 tonnes of CO2 emissions over the coming 25 years, the equivalent output of 525 typical Australian homes in the same timeframe, according to USC.

New Atlas, 3 November 2019

<https://newatlas.com>

China perfected fake meat centuries before the Impossible Burger

2019-11-13

When 29-year-old Wang Jianguang was growing up in a poor neighbourhood in China's northern Shanxi province, his family would buy him chicken wings with soy sauce as a rare treat. Except they weren't actually made of chicken. The wings were an intricate combination of soybeans and peanuts. "They looked just like chicken wings, though," Wang said. It was his first encounter with China's centuries-old tradition of imitation meat dishes. In the past few years, demand for fake meat products has surged in the Western world, as people seek environmentally sustainable and healthier alternatives to red meat. Two of the biggest US plant-based food companies, "Impossible Foods" and "Beyond Meat," have made millions from a growing appetite for meat-free burgers. By mid-2019, there were so many orders for "Impossible Meat" the company admitted it was struggling to keep up. But long before the first plant-based patties hit the grill in the West, China had been sculpting and flavouring traditional meat-based dishes out of mushrooms, nuts and vegetables. "It shadows and parallels Chinese cuisine ... it is incredibly diverse and in every part of the country you have a different version," said food writer Fuschia Dunlop. Some records of monks eating tofu-based "vegetarian meat" date back as early as the Song Dynasty in the 10th century. It was known as "fanghun cai" or literally "imitation meat dish." Wang now works at a restaurant called Baihe Vegetarian in the traditional hutong alleyways of Beijing's Dongcheng district. They serve a huge range of fake meat dishes -- pork spare ribs, dumplings, kung pao chicken. The restaurant's owner Liu Hongyan said between 80 and 100 people regularly visit her restaurant each day and the number is rising. "I think more and more people are embracing vegetarian culture. People are considering

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their health," she said. "There's too much fat and oil in red meat," she said. China's early adoption of fake meat products is closely linked to its long history of Buddhism. Buddhism was introduced to China as early as the Han Dynasty, around 2,000 years ago. Over the centuries, its popularity has risen and fallen in line with the preferences of the country's leaders. Today, it's practiced by around 20% of China's population -- some 250 million people. A central tenet of Buddhism is respect for all living creatures, and vegetarianism is common among its followers. Dunlop said that while China's monasteries provided a strict vegetarian diet, they would often have to accommodate for the dietary choices of visiting pilgrims or patrons. "[The visitors] would expect [meat-based] meals and this was where the tradition came from. You'd get all the dishes you'd expect to eat at a banquet, but made from vegetarian ingredients." Chinese Buddhist vegetarian food became "extraordinarily sophisticated" in the centuries after the Han Dynasty, according to Dunlop. "In the larger monasteries ... people could dine on grand dishes of "shark's fin," "abalone" and other delicacies cunningly fashioned from vegetable ingredients," Dunlop wrote in her book "Food of Sichuan. Today, she said the widespread influence of imitation meat can be seen in the range of dishes offered. In Shanghai, you can eat stir-fried "crabmeat" made from mashed potato and carrot. In Sichuan, restaurants offer traditional "twice-cooked pork" made without a scrap of meat. "Everyone in Shanghai eats vegetarian "roast duck" or "goose," which is made from layers of thin tofu skin, which are flavoured and then deep fried so that it has a golden skin like the real dish," Dunlop said. There are now more than 300 restaurants offering fake meat in Beijing alone, according to China Daily. But China is far from being a nation of vegetarians -- meat consumption is still huge. In the past 60 years, demand for pork has led to a 10-fold jump in the number of pigs slaughtered per person. As Chinese people have become richer, the demand for meat has risen at the same time. But even that rise in meat consumption may have helped push people towards vegetarian imitations. As recently as 2014, problems with tainted meat were being discovered in the country's largest food processing centres. "Some people are quite worried about the source of the meat, but don't want to lose that taste," Dunlop explained. Wang takes great pride in creating his wide range of fake meat dishes at Baihe Restaurant. In his kitchen, he carefully shapes a single, large king oyster mushroom into small cubes which will soon become vegetarian "kung pao chicken." Adding flour, oil, cashews and sugar, among other ingredients, the mixture is tossed into a boiling hot wok. The final piping-hot product has the signature sweet-but-savory taste, with a consistency similar to the meat it's intended to mimic. According to Wang, in recent years industrialisation has meant much of China's fake meat comes from

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factories rather than being made in kitchens. He makes all his dishes by hand. "For example, for pork ribs, the bone is made from lotus root, while the meat is made from potato, mushrooms and peanut protein," Wang said. He said the ribs need to sit overnight before they're ready to be served. While both Wang and owner Liu are aware of Western fashions in fake meat, they're both dismissive of the trend. For them, the original Chinese version is more sophisticated. "Chinese vegetarian food is more complicated than the Western version. It has more forms, more tastes. The Western version is simple," Wang said. "I feel like Westerners only eat burgers and steaks."

CNN, 4 November 2019

<http://www.cnn.com/health>

New Zealand passes historic law to decarbonise economy by 2050

2019-11-13

In what is being hailed as a historic moment for the island nation of five million people, New Zealand's parliament has passed new legislation that commits the country to a carbon neutral economy by 2050. The bill garnered support from both sides of politics, and seeks to ensure future governments also do their bit to keep global warming to a maximum of 1.5° C (2.7° F) above pre-industrial levels. First introduced back in May and passed into law on Thursday, the Zero Carbon Bill is designed to put New Zealand on a path to entirely decarbonizing its economy by 2050. Key to this strategy is the establishment of an independent Climate Change Commission, which will provide advice on the best way to reach this target. Moving forward, future governments of New Zealand will be required to set new emissions budgets every five years, which will serve as stepping stones toward the ultimate objective. The new legislation also requires governments to both understand and act on the risks of climate change – for example, rising sea levels or the loss of flora and fauna. "We have to start moving beyond targets, we have to stop moving beyond aspiration, we have to start moving beyond statements of hope and deliver signs of action," New Zealand's Prime Minister Jacinda Ardern told parliament on Thursday. "That is what this government is doing, and proudly so." In implementing what is being hailed as landmark legislation, which drew support from both Adern's government and the opposition National party to pass 119 votes to one, New Zealand joins just a small handful of nations to commit to net-zero carbon economies through law. Bhutan and Suriname are already carbon negative, while Norway

In what is being hailed as a historic moment for the island nation of five million people, New Zealand's parliament has passed new legislation that commits the country to a carbon neutral economy by 2050.

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and Sweden have laws in place to work toward carbon neutrality by 2050. France and Britain, which both passed laws earlier this year, were two big additions to the list, while other large countries like Spain and Germany have proposals under consideration. Promisingly, many more have pledged to take climate action under the Paris Agreement, among which 65 countries committed to net zero carbon emissions by 2050 at the UN's Climate Action Summit in September. The United States, the world's second largest emitter of carbon dioxide, this week formally withdrew from the Paris Climate Accord.

New Atlas, 7 November 2019

<https://newatlas.com>

CDC Investigators Have Linked Vitamin E To Deadly Vaping Injuries

2019-11-13

Federal health officials linked vitamin E acetate to a nationwide outbreak of deadly vaping-related lung injuries on Friday after finding the oil in the lungs of patients in a 10-state sample. "For the first time, we have a definite contaminant of concern: vitamin E acetate," Anne Schuchat, principal deputy director of the CDC, told reporters in a telephone briefing, calling the study a breakthrough in the outbreak investigation that has been underway since August. Recently, the CDC reported more than 2,000 cases of vaping-related lung injuries in the last three months, including 39 deaths, in the 49-state outbreak. The injuries are marked by severe shortness of breath, pneumonia-like symptoms, and a rapid onset — largely seen among young people who had vaped THC, the ingredient in marijuana that gets you high. In the new study reported by the CDC, investigators looked at fluid from the lungs of 29 patients. All of them had vitamin E acetate in their lung fluid samples. No other suspected oils or plant material seen in the vaping liquid cartridges turned up in detectable amounts. Found in hand lotion, food, and vitamin pills, the oil had already come up in some state investigations of illicit vaping pods linked to the cases, notably in New York. But the new results are the first to detect the substance in patients' lungs. It has apparently been added to vaping liquids to improve appearance and dilute the THC sold by dealers. "There's a big difference between rubbing it on your hands or swallowing a vitamin E pill and inhaling aerosolized vitamin E acetate," said Schuchat, noting past studies linking its high-temperature vaporised form to pneumonia and reduced lung function. Jennifer Layden of the Illinois Department of Public Health told reporters that, in a related survey of 4,000 people

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who vape in her state, people with lung injuries were nine times more likely to have vaped illicit liquids bought from friends or on the street, and were eight times more likely to have used “Dank” vapes, a line of refillable vaping cartridges that are often counterfeited. No injuries were reported connected to the state’s regulated medical marijuana dispensaries, she added. The fact that vitamin E acetate turned up in the lungs of patients from 10 states, rather than from just one location, adds to the weight of the lung fluid study, said Schuchat. However, she cautioned that other contaminants might also be causing injuries, and that the outbreak might have multiple causes. She reiterated strong advice for people not to vape liquids bought on the street or from friends or family: “This is a very severe disease.”

Buzz Feed News, 8 November 2019

<https://www.buzzfeednews.com>

Failing 15% of The Time Is The Best Way to Learn, if At All Is Anything to Go By

2019-11-13

Getting everything right all of the time might sound like the ideal scenario, but such a perfect success rate can mean you’re not actually learning anything new. To make sure you’re learning at the optimal rate, new research finds you should be aiming to fail around 15 percent of the time – or 15.87 percent of the time, to be exact. These findings could have implications for training courses, teaching in classrooms, and everywhere that learning happens. It’s that sweet spot between finding something too easy and too difficult. “These ideas that were out there in the education field – that there is this ‘zone of proximal difficulty’, in which you ought to be maximising your learning – we’ve put that on a mathematical footing,” says psychologist Robert Wilson from the University of Arizona. To come up with the 15/85 percent split, Wilson and his colleagues ran a series of machine learning experiments. The experiments were designed to teach computers how to do simple tasks, such as putting patterns into categories, or recognising the difference between odd and even numbers. The computer systems learnt fastest, the researchers found, when they were making the right call 85 percent of the time. That figure seems to match up with previous studies carried out with animals, too. According to the team, this sort of split is most likely to apply to humans when it comes to perceptual learning, where we gradually learn through experience and examples (not unlike a machine learning algorithm). Take a radiologist learning to tell the difference between images of tumours and non-

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tumours, for example: at a level that's too easy, the radiologist would identify 100 percent of the images correctly. At a level that's too difficult, that might drop to somewhere around 50 percent. But if the radiologist is correctly identifying 85 percent of the images and making mistakes with the other 15 percent, that could be the spot where the learning rate is the fastest. Of course, as we gain more knowledge, that difficulty level needs to be adjusted again, to keep the learning task at just the right level in terms of how challenging it is. The researchers are also keen to point out that their study only covers basic, binary choices – it doesn't necessarily follow that we should all be aiming for an 85 percent grade in our future exams. More research is going to be needed to figure out how this applies more broadly to education, outside of computer algorithms. For now though, it's a good starting point for finding that balance between something that's so easy we get bored, and so difficult we give up – a quandary that educators have been thinking about for a long time. "If you are taking classes that are too easy and ace-ing them all the time, then you probably aren't getting as much out of a class as someone who's struggling but managing to keep up," says Wilson. "The hope is we can expand this work and start to talk about more complicated forms of learning." The research has been published in Nature Communications.

Science Alert, 9 November 2019

<http://www.sciencealert.com.au>

What hypnosis does to your brain, and how it can improve your health

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"Honestly, I wondered whether I was actually in labour, because surely it was meant to be more painful than this." That's Shona, describing the recent birth of her daughter. Her secret? Hypnosis. During pregnancy, she learned how to hypnotise herself into a state of mind that allowed her to minimise the pain of labour and, in her own words, "quite enjoy the whole thing". The word hypnosis may call to mind a swinging watch or an entertainer getting people to believe they are naked on stage for an audience's amusement. Its history is one of sorcery and magic, tales of the occult and exploitative charlatans. Practitioners are rarely doctors or counsellors, clinical trials struggle to get funded and there is still no regulatory authority that monitors the practice. Yet despite these issues, people are turning to the technique to help with everything from labour to hot flushes, anxiety and chronic pain, and a growing body of research is starting to confirm its benefits. We are also beginning to get

The history of hypnotherapy is riddled with hucksters, but it can provide real benefits – from weight loss to managing pain. Why modern medicine is starting to take it seriously

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a handle on how it actually works and what happens in the brain during hypnosis. The result is that how we define hypnosis is changing, and its use in mainstream medicine is increasing. The UK's Royal College of Midwives now accredits hypnobirthing courses and funds training in the technique. Some anaesthetists now include hypnosis in their toolkit, and it is even being touted as a solution for the opioid addiction crisis. Hypnosis is certainly no cure-all, but learning what works, why it works and how to do it ourselves may help us harness the power of the mind for some of life's toughest battles. Hypnosis has a long history in medicine. The earliest recorded use dates to 1550 BC, but it took off in the 18th century when German physician Franz Mesmer decided that the planets' physical influence on people could be manipulated using magnets to cause a trance and treat disease. Mesmer was later denounced as a fraud and hustler, but the idea of changing people's behaviour through trance persisted, and gained more credibility in the 19th century when the Scottish surgeon James Braid began to investigate what physiology might underlie this strange phenomenon. "You've probably been in a trance, when you were so absorbed you didn't notice the passage of time" Today, hypnosis is used for a vast range of conditions. But even as its use has become more common, its reach within medicine has been limited. In part that is because few can agree on what exactly hypnosis is. Cobbling together opinions from several researchers, a hypnotic "trance" could be described as a state of focused attention, concentration and inner absorption, accompanied by a loss of awareness of the other things around you. It is a state you are likely to have experienced before – when you have been so absorbed in an activity that you don't notice anything around you or the passage of time. We also now know that the success of famous illusionists getting people to do weird and wonderful things on stage has more to do with peer pressure than it does with being hypnotised.

Smoke and mirrors

No hypnotist can make you do something against your will, despite what TV mentalist Derren Brown's stunts may suggest. Back in 1939, scientists did show that hypnotised volunteers would perform risky acts, like picking up poisonous snakes, suggesting they weren't acting of their own volition. But later experiments revealed that most people would do these things whether hypnotised or not, merely because they had been put under pressure by a person in authority. When asked to perform the same acts outside such settings, participants all said no. "It's true that the people who are brought on stage and hypnotised feel compelled to behave in the

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way they do," says Michael Heap, a clinical psychologist at the University of Sheffield, UK. "Mainly it's because these people are placed in front of an audience. They know what's expected of them. They're actually just obeying the hypnotist, they're cooperating, complying with authority." When it comes to how to actually hypnotise someone, there is no standard method. A common approach starts with thinking of a calming image, before imagining yourself in a peaceful setting that stimulates all your senses, followed by a deepening procedure and affirmations that help you achieve your goal. It can be induced by another party or by yourself. As we'll see, there are good reasons to keep calling the process "hypnosis", but its fuzzy definition and controversial history have made it difficult to figure out what works and what doesn't. Its classification as "complementary" rather than mainstream therapy by the UK's National Health Service (NHS) hasn't helped either, says Jane Boissière from the British Society of Clinical and Academic Hypnosis, because it makes obtaining funding for trials, training or setting up relevant services in the NHS "virtually impossible". In spite of this, the UK's National Institute for Health and Care Excellence does recommend hypnosis for one condition: irritable bowel syndrome. IBS causes painful cramps, bloating, diarrhoea and constipation. The cause isn't known and there is no cure, but some drugs and diet changes can ease symptoms. And for treatment-resistant IBS, there is overwhelming evidence that hypnosis can improve symptoms and quality of life. "During hypnosis, patients might picture the gentle waves of the sea, and imagine their bowels are moving in a similar regular, quiet rhythm," says Carla Flik at University Medical Centre Utrecht in the Netherlands. In the US, both the American Psychological Association and the National Institutes of Health now promote hypnosis as part of standard care for pain. Numerous studies have shown that it can improve a variety of chronic problems, such as lower back pain and side effects of cancer treatments – often offering more relief than physical therapy and cognitive behavioural therapies alone.

How to hypnotise yourself

Start with 5 minutes of calming imagery, such as imagining your favourite colour washing over you, or thinking about floating in a pool of water, while concentrating on your breath. Next, imagine yourself in a happy place – somewhere peaceful that stirs your senses; you can smell, touch, hear and see the different aspects of the images around you. If you are imagining a day at the beach, for instance, you can visualise the bright sky above you, feel the warmth of the sun on your skin, taste and smell the salt in the air and hear the sounds of the waves rolling in and out. Next, it

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is time to go deeper. To make yourself feel even more relaxed, think about descending a spiral staircase, for instance. Now repeat affirmations that help you achieve your desired outcome. Hypnosis can be so effective for pain relief that, since 1992, it has been used in many surgical procedures – including biopsies, laparoscopies and plastic surgery – as an alternative to general anaesthesia. The technique is simple, says Aurore Marcou at the Curie Institute in Paris, France. “The patient receives a local anaesthetic and mild sedation. We sit beside them and guide them to concentrate on their inner world, their breathing, and help them bring their attention to a safe space. We help them relive experiences in the past. All of your brain is focused on those memories.” The major benefit is fewer side effects. “You don’t feel drowsy, or sick from the general anaesthetic,” says Marcou. Guy Montgomery at the Icahn School of Medicine at Mount Sinai, New York, has found that women who had hypnosis before breast cancer surgery reported less pain, anxiety, nausea and fatigue afterwards. And the benefits weren’t just physical. His team predicted that if 90 per cent of people needing a breast cancer biopsy in the US were to undergo hypnosedation, it would save the country more than \$135 million a year.

Going deeper

This reported reduction in mental and physical symptoms makes it no surprise that pregnant women like Shona flock to hypnobirthing classes. Officially, though, the jury is still out on this one – a 2011 review of 13 studies concluded that hypnobirthing “holds promise” as an intervention for labour pain, but so many of the trials were poorly designed that a more definitive answer wasn’t possible. A 2015 trial found the technique made little difference to whether women requested pain relief during childbirth, but it did significantly reduce their reported levels of fear and anxiety. Indeed, many see promise for its use in mental health. Anxiety disorders are some of the most impairing and common conditions in the US. This year, in the first analysis of its kind, Keara Valentine at the University of Hartford, Connecticut, and her colleagues quantified the effect of hypnosis for reducing anxiety by analysing all of the controlled studies of this intervention. The results were impressive: the average participant receiving hypnosis showed more improvement than 84 per cent of people who didn’t receive it. What’s more, there was no difference in benefit between those who used self-hypnosis and those given guided hypnotherapy. Hypnosis isn’t just used for pain and anxiety, of course. It is increasingly popular as a way to help people learn new behaviours or kick bad habits. But, again, the research is mixed because of poor trial design. In June, Jamie Hartmann-Boyce at the University of Oxford

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and her colleagues published a review of 14 studies analysing the use of hypnosis to help people give up smoking and couldn't find sufficient evidence to recommend it. The problem wasn't that hypnosis definitely didn't help, she says, but that the trials were a mess. "They had lots of bias, were imprecise or had too few participants," Hartmann-Boyce says. "It's such an important issue that we need to produce bigger, better trials." In other areas, results are more consistent. For instance, in the early 1990s, a meta-analysis of weight-loss studies showed that adding hypnosis to cognitive behavioural therapy more than doubled how much weight people lost. Another meta-analysis done in 2018 had equally encouraging results. Despite this increasing evidence of hypnotism's potential, there remain many questions regarding how it actually works. But that too is starting to change. "I don't think anyone should say 'yes we know exactly what hypnosis is,'" says Laurence Sugarman at the Rochester Institute of Technology in New York, "but we have some ideas." First, he says, we shouldn't think about hypnotism as something that induces a single state, but as a discipline that influences the brain's ability to adapt and learn. "It's a skill we can use to help us change our mind."

This adaptability – which is also known as plasticity – lets the brain modify its neural connections and rewire itself so that we can perform novel behaviours, remember new information and adapt to the variety of experiences life throws at us. There are times when the brain is more plastic – the first few years of life, for instance, or when we experience strong emotions. It is likely that hypnosis puts our brain in a state that is conducive to remoulding, not in one specific way, but in many different ways depending on the individual and the therapy involved. "For treating anxiety, self-hypnosis or guided hypnosis were equally good". For instance, imaging studies show that the relaxation part of hypnotic induction significantly suppresses activity in our frontal cortex, the brain area responsible for planning, decision-making and attention. This releases the brake that it normally puts on other areas involved in filtering and integrating salient information from inside and outside our body, which we use to generate new memories, ideas and behaviours. Something similar happens when we drink alcohol, a time when you might also feel more suggestible. It seems that while in the hypnotic state, we can generate more intense sensations in our mind. Marie-Elisabeth Faymonville, head of the pain clinic at Liège University Hospital in Belgium, has found that people who are hypnotised and asked to imagine a pleasant memory show more activity in brain areas responsible for movement and sensations than people who are merely imagining the same scene without hypnosis. "There was no real stimulation coming

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from the outside world, but those who were hypnotised were seeing as if their eyes were open and information was coming in. It was similar to real perception," she says. The stronger such sensations are – imagined or otherwise – the more easily they can be incorporated into a learned behaviour. When it comes to controlling pain, hypnotism seems to help in a different way. Pain perception is generated by the brain, and we know that it can be influenced: consider the gymnast who breaks their leg halfway through a routine and carries on, or a mother who saves her child from a burning building before noticing her own injuries. Hypnotism seems to allow us to do something similar.

On your wavelength

When Faymonville hypnotised volunteers before pressing a warm or painfully hot stimulus on their palm, it lowered the perceived unpleasantness and intensity of the pain by about 50 per cent compared with subjects who were just resting, and by about 40 per cent compared with those told to distract themselves with a pleasant memory. A closer look at the brain in this context shows that hypnosis lowers activity in the anterior cingulate cortex, a region that receives information about sensory stimuli and is linked to areas that organise an appropriate emotional, behavioural response. Lower activity in this area may mean that pain signals are given less attention than normal. Other research suggests that hypnosis gets people into a state of mind where the associated brainwaves – patterns of neural activity – are similar to those seen during deep meditation. In a small study of people with multiple sclerosis who underwent hypnosis to treat chronic pain, Mark Jensen at the University of Washington, Seattle, and his colleagues found that enhancing the theta brainwaves generated during a hypnotic trance increased the potency of the pain relief. That may be because the brainwaves generated during a hypnotic trance aid the brain's ability to learn and adapt to the new information it is receiving during the therapy. Despite this progress, there remain challenges: not least convincing doctors to keep an open mind. According to Montgomery, many trainees ask: "Do we have to call it hypnosis? That word may scare patients off." The short answer is yes. When people undergo the same procedure labelled either hypnosis or relaxation or suggestion, it works better when called hypnosis. Motivation to be hypnotised, as well as believing it is a credible therapy, can also increase the likelihood that it is effective. As with the placebo effect, it may be that your belief hypnosis will make a difference is in fact a critical part of the success of the treatment. Giving hypnosis a fair shot in mainstream medicine could have big pay-offs. Studies show that people with chronic

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pain can lower their use of painkillers through hypnosis. In the US, more than 130 people die every day from overdoses involving addictive prescription painkillers, most notably opioids. Speaking at last year's World Economic Forum, psychologist David Spiegel at Stanford University in California pointed out that hypnotism isn't addictive and doesn't kill people, yet it can have a considerable effect on pain, and is therefore worth taking seriously. Does hypnosis work for everyone? No. But you can try it on yourself for free and it comes with minimal risks, says Marcou. "That's what's so nice about hypnosis – the results can be really good; you just need to be willing to give it a go."

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