Bulletin Board
APR. 05, 2019

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CHEMWATCH

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ASIA PACIFIC

Australia's NICNAS proposes 'managing' use and import of decaBDE

2019-03-29

Australia's national chemicals agency. The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) has published a draft 104-page risk assessment report on the flame-retardant chemical, decabromodiphenyl ether (decaBDE). The substance is listed as a priority existing chemical (PEC) in the country. The document assesses current evidence on the use of the substance and its effect on health, workers and the environment. It covers:

- import volume trends;
- usage by industry sector;
- studies of effects on human and environmental exposure; and
- regulatory initiatives in different countries.

Instead of providing specific policy recommendations, the report advises the government to "explore options" for managing the use and import of decaBDE based on the collated evidence. The substance is not manufactured in Australia.

Proposals based on collated evidence on the priority existing chemical

DecaBDE was added to Annex A of the Stockholm Convention on persistent organic pollutants, to which Australia is a signatory, in 2017. Substances in Annex A are marked for elimination, subject to exemptions. Exemptions for DecaBDE allow its use in certain vehicle and aircraft parts and in polyurethane foam for building insulation. Several jurisdictions are reviewing the risk of the substance. Recently, Taiwan listed it under Classes 1 and 2 of its Toxic Chemicals Substance List and the city of Anchorage in Alaska, US approved an ordinance banning it in certain consumer products. Stakeholders providing feedback on the draft, such as updating the language or including additional evidence, can submit requests for "variation" of the report until 1 April. Further information is available at: Nicnas report

Chemical Watch, 27 March 2019

http://chemicalwatch.com

Regulatory Update

Draft Cost Recovery Implementation Statement (CRIS) 2019-20

2019-03-29

The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) has published a draft Cost Recovery Implementation Statement (CRIS). Public comment is invited on the draft CRIS. The CRIS provides information on how the current scheme (NICNAS) implements cost recovery for its regulatory activities. Its purpose is to transparently demonstrate compliance with the Australian Government's Cost Recovery Guidelines and to outline proposed changes to existing regulatory fees and charges in 2019-2020. A copy of the draft document is available at: Download the draft CRIS 2019-2020

NICNAS, 21 March 2019

http://www.nicnas.gov.au

South Korea Consults on Hazard Evaluation Results of New Substances Registered under K-REACH

2019-03-29

South Korea's National Institute of Environmental Research (NIER) is now consulting on the hazard evaluation results of new chemical substances registered under K-REACH by NIER Notice No. 2019-129. Any comments are welcome before 3 April 2019. The proposed updates include:

- Update the hazard evaluation results of 44 new substances previously assessed (given number as 2015-47, 2016-110, 2016-297, 2016-345, 2016-417, 2016-481, etc.)
- Update the chemical name of 2 new substances previously assessed (given number as 2016-56 and 2016-163)
- Add hazard evaluation results of 219 new substances (given number as 2019-1 ~ 2019-219) registered under K-REACH during Oct to Dec 2017.

The details of proposed updates are accessible at: Proposed Update.
Further information is available at: NIER Notice No. 2019-129

Chemlinked, 20 March 2019

http://chemlinked.com/en/news

The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) has published a draft Cost Recovery Implementation Statement (CRIS).

Regulatory Update

MIIT Consults on Two Mandatory National Standards for Coatings

2019-03-29

On 21 March, the Chinese Ministry of Industry and Information Technology issued a notice to solicit public comments on two new mandatory national standards for coatings, namely the *Limit of Harmful Substances of Marine Coatings* and the *Limit of Harmful Substances of Interior Floor Coatings*.

Limit of Harmful Substances of Marine Coatings

The *Limit of Harmful Substances of Marine Coatings* is devised to impose a limit on substances in marine coatings which are harmful to human health and the environment, including VOCs (only those contained in marine coating for steel ships), solvents of which the use is restricted, heavy metal, biocides, asbestos, etc. It stipulates terms and definitions, product classification, requirements, testing methodologies, examination rules, and packaging and labelling concerning marine coatings. The standard is applicable to various marine coatings which are used as major materials for hulls, such as steels, light-weight alloy, and fibre-reinforced plastics. Meanwhile, as fireproof coatings are subject to the regulation of specialised authorities, it is specifically noted that they are not included in the application scope of the standard.

Limit of Harmful Substances of Interior Floor Coatings

The *Limit of Harmful Substances of Interior Floor Coatings* provides terms and definitions, product classification, requirements, testing methodologies, examination rules, and packaging and labelling concerning the limit of harmful substances in interior floor coatings. And such substances include VOCs; methanol; HDI and TDI; benzene, methylbenzene, ethyl benzene, and dimethylbenzene; heavy metal; ethylene glycol ether; various phthalates; etc. The standard is applicable to various interior floor coatings which are used as decorative and protective (or antistatic, corrosion-proof, or anti-skid) materials for floors, painted on floor base surfaces which are made of cement mortar, concrete, stones, plastic cement or steels, and glued majorly using organic polymers as adhesives. It is expected that the standard will greatly facilitate technological advances and eco-friendly development of the interior floor coatings industry.

On 21 March, the Chinese Ministry of Industry and Information Technology issued a notice to solicit public comments on two new mandatory national standards for coatings, namely the Limit of Harmful Substances of Marine Coatings and the Limit of Harmful Substances of Interior Floor Coatings.

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Further information is available at: MIIT Notice

Chemlinked, 22 March 2019

http://chemlinked.com/en/news

AMERICA

US EPA publishes REACH studies underlying TSCA PV29 evaluation

2019-03-29

The United States Environmental Protection Agency (EPA) has released additional information on two dozen studies used to underpin a TSCA risk evaluation that had previously been withheld as confidential. The protected status of the 24 health and safety studies – which the EPA used in developing the November 2018 draft evaluation for pigment violet 29 – has been the subject of controversy. Consumer advocacy groups have argued that such data is not eligible for protection as confidential business information (CBI) and filed a public records request to access it. At the same time industry defended the commercial value of the studies, particularly for substances registered under the EU's REACH Regulation. Democrats in Congress, meanwhile, have continued to press for public release of the information. In its announcement, the EPA says the data-owning companies have "revised their confidentiality claims, dropping most of them". This has resulted in the agency publishing the full studies or expanded summaries of them – including for 20 submitted to ECHA when PV29 was registered in Europe – where only robust summaries had been available previously. The EPA has reviewed the remaining CBI claims and determined that the information is entitled to protection. That information, it added, has been redacted from the publicly released studies. In announcing the release of the data, EPA Office of Chemical Safety and Pollution Prevention (OCSPP) Assistant Administrator Alexandra Dunn said the agency is "committed to being transparent with information on chemicals, as we work to develop risk evaluations under TSCA".

Data owners 'revised their confidentiality claims', says agency

Ms Dunn made similar comments when speaking at the American Chemistry Council's GlobalChem conference in Washington, DC earlier this month, telling attendees that the agency has learned from the responses it received on PV29 and will be more careful around CBI protections. "We are committed to the transparency around this and the other nine chemicals" being evaluated under the reformed TSCA, she said at the time. The release

of the studies has not affected the 'no unreasonable risk' determination laid out in the draft risk evaluation. The EPA said, however, that it will be reopening the comment period on the assessment to allow for feedback on the new information. The peer review panel for PV29 – which was cancelled during the partial government shutdown earlier this year – is in the process of being rescheduled. Further information is available at:

- EPA release
- PV29 studies
- PV29 docket

Chemical Watch, 25 March 2019

http://chemicalwatch.com

House Subcommittees Hold Hearing on EPA's IRIS Program

2019-03-29

On 27 March 2019, the United States House Science, Space, and Technology Subcommittee on Investigations and Oversight and Subcommittee on Environment held a hearing on "EPA's IRIS Program: Reviewing its Progress and Roadblocks Ahead." The hearing focused on issues with the U.S. Environmental Protection Agency's (EPA) Integrated Risk Information System (IRIS) Program, as described in two recent reports issued by the U.S. Government Accountability Office (GAO), *Chemical Assessments: Status of EPA's Efforts to Produce Assessments and Implement the Toxic Substances Control Act* (Chemical Assessments Report) and *High-Risk Series: Substantial Efforts Needed to Achieve Greater Progress on High-Risk Areas* (High-Risk Report).

On 27 March 2019, the United States House Science, Space, and Technology Subcommittee on Investigations and Oversight and Subcommittee on Environment held a hearing on "EPA's IRIS Program: Reviewing its Progress and Roadblocks Ahead." The hearing focused on issues with the U.S.

Background

"GAO Reviews EPA's IRIS Assessment Efforts and Implementation of TSCA Reforms," on 4 March 2019, GAO published the Chemical Assessments Report. The Chemical Assessments Report describes the extent to which the IRIS Program has addressed identified challenges and made progress toward producing chemical assessments; and assesses whether EPA has demonstrated progress implementing the Toxic Substances Control Act (TSCA). GAO reports that, in June 2018, EPA leadership in the Office of Research and Development (ORD) reportedly told IRIS officials not to release any IRIS-associated documentation without a formal request from EPA program office leadership. In August 2018, EPA program office leadership was asked to reconfirm which ongoing IRIS assessments

their offices needed. In late October 2018, leadership in ORD reportedly asked these offices to limit their requests further, to the top three or four assessments. GAO states that at the same time, four months after IRIS assessments were stopped from being released, 28 of approximately 30 IRIS staff were directed to use 25 to 50 percent of their time to support TSCA implementation. When EPA deliberations about the IRIS Program's priorities were completed, a memorandum was issued on 4 December 2018, listing 11 chemical assessments that the IRIS Program would develop. Although this was a reduction of the Program's workflow from 22 assessments, GAO states that the memorandum "gave no reason for the reduction." GAO notes that it received this memorandum at the end of its review and did not have the opportunity to review the prioritisation process that led to its drafting. In its 6 March 2019, High-Risk Report, GAO included "Transforming EPA's Process for Assessing and Controlling Toxic Chemicals" on a list of three areas that have regressed in their ratings against GAO's criteria for removal from the High-Risk List. GAO notes that since adding this area to its High-Risk List in 2009, it has made 12 recommendations to EPA related to the IRIS Program and TSCA. According to GAO, while EPA has taken steps to manage chemicals that pose risks to human health and the environment, leadership and implementation challenges remain.

Hearing

The first panel of witnesses included: Dr. Jennifer Orme-Zavaleta, Principal Deputy Assistant Administrator for Science for ORD, EPA Science Advisor, EPA; and Mr. Alfredo Gomez, Director, Natural Resources and Environment, GAO.

Members of the Committee and Subcommittees had a number of questions regarding the GAO's finding that EPA leadership in ORD reportedly told IRIS officials not to release any IRIS-associated documentation without a formal request from EPA program office leadership. Members also focused on the two surveys conducted to determine IRIS priorities: the first, in August 2018, asking EPA program office leadership to reconfirm which ongoing IRIS assessments their offices needed; and the second, in late October 2018, asking these offices to limit their requests further, to the top three or four assessments. On 4 December 2018, a memorandum was issued listing 11 chemical assessments that the IRIS Program would develop. Gomez expressed concern about the increased involvement of political leadership in ORD, such as the directive that IRIS officials not release any IRIS documents without instruction from EPA program office leadership. Orme-Zavaleta

stated that she was not involved in the discussions between the first and second surveys of the EPA program offices. She noted that after receiving responses to the first survey, there was concern that the requests for 50 or so chemicals were too large for IRIS to manage. For the second survey, she received "templates" that were signed off on by the assistant administrators for the offices, for a total of 11 chemicals. The templates reported the priority chemical assessments that were needed and by when, and how the IRIS assessments were to be used by program offices. Representative Paul Tonko (D-NY) asked about the responses submitted by the Office of Children's Health Protection (OCHP). According to Orme-Zavaleta, she received OCHP's response to the second survey the day after the 4 December 2018, memorandum was issued. Orme-Zavaleta stated that EPA will be sending another request to program offices this summer. Questions also focused on the status of the IRIS handbook, which is expected to provide guidance for the development of IRIS assessments. According to GAO's Chemical Assessments Report, in early November 2018, IRIS officials informed GAO that EPA had almost completed internal review of the handbook, which was being prepared for public release. During the hearing, Orme-Zavaleta stated that the government shutdown delayed work on reviewing and responding to internal comments on the handbook. According to Orme-Zavaleta, although the handbook is not a final document, elements of the handbook have been used in recent IRIS assessments. Members also addressed the status of the IRIS assessment for formaldehyde, which has reportedly been ready since the end of 2017 but was not included on the December 2018 list of priority chemicals and, according to GAO's Chemical Assessments Report, its future is unknown. Orme-Zavaleta stated that she believes the draft IRIS assessment will help EPA evaluate formaldehyde as a high-priority prioritisation process candidate under TSCA.
Witnesses on the second panel included:

Dr. Bernard D. Goldstein, Professor Emeritus, Dean Emeritus, University of Pittsburgh Graduate School of Public Health; Dr. Ivan Rusyn, Professor, Department of Veterinary Integrative Biosciences, Texas A&M University; Chair, Interdisciplinary Faculty of Toxicology; Director, Texas A&M Superfund Research Centre; Dr. Julie E. Goodman, Principal, Gradient; and Ms. Wilma Subra, President, Subra Company; Technical Advisor, Louisiana Environmental Action Network.

Questions for the second panel from the Committee and Subcommittee members focused on the usefulness of the IRIS Program. Goldstein stated that IRIS was intended to coordinate risk assessments throughout EPA,

ensuring that the programs used the same science and minimising the influence of political appointees. When asked how Congress can support career staff at EPA, Goldstein recommended that Congress provide as much oversight as it can. According to Rusyn, the IRIS Program is a leader in pushing risk assessment methodology forward, most recently in its implementation of systematic review.

Commentary

The hearing was largely a recap of what was already known about the IRIS program, including EPA's efforts to prioritize IRIS assessments as described by the recent GAO reporting. Perhaps not surprisingly, IRIS came under criticism from both majority and minority members. The issues raised included timeliness of outputs, IRIS' long ongoing efforts to improve and strengthen its assessments and approach, the status of the IRIS assessment handbook, and the effect of EPA's political leadership on the program. Apart from the delay and disruption of ongoing work, we can see the benefit of EPA leadership efforts to obtain clear written statements of the priorities as seen by program Assistant Administrators. Perhaps this type of confirmation step will be an ongoing feature of the IRIS program into the future.

National Law Review, 28 March 2019

http://www.natlawreview.com

On 25 March 2019, the United States Environmental Protection Agency (EPA) posted Draft Guidance for Plant Regulator Label Claim, Including Plant Biostimulants.

EPA Releases Draft Guidance for Pesticide Registrants on Plant Regulator Label Claims, Including Plant Biostimulants

2019-03-29

On 25 March 2019, the United States Environmental Protection Agency (EPA) posted Draft Guidance for Plant Regulator Label Claim, Including Plant Biostimulants. On 27 March, EPA issued the notice of availability in the *Federal Register*- Fed. Reg. 11538. Comments on the draft guidance are due by 28 May 2019. EPA states that the draft guidance is intended to "provide guidance on identifying product label claims that are considered to be plant regulator claims" by EPA under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and thereby distinguish claims that would not subject plant biostimulants (PBS) to regulation under FIFRA as plant regulators. While EPA has not yet promulgated a regulatory definition for a PBS, the draft guidance describes a PBS as "a naturally-occurring substance or microbe that is used either by itself or

in combination with other naturally-occurring substances or microbes for the purpose of stimulating natural processes in plants or in the soil in order to, among other things, improve nutrient and/or water use efficiency by plants, help plants tolerate abiotic stress, or improve the physical, chemical, and/or biological characteristics of the soil as a medium for plant growth." EPA is seeking comment on the draft guidance itself, as well as on whether it should develop a definition for PBSs. EPA states that there is currently no statutory definition for PBSs under FIFRA and that development of a definition for PBSs would require rulemaking. The guidance also notes that the 2018 Farm Bill, enacted on 12 December 2018, does provide a statutory definition for PBSs, which is: "a substance or micro-organism that, when applied to seeds, plants, or the rhizosphere, stimulates natural processes to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, or crop quality and yield." In developing the draft guidance, EPA states that it "considered whether a PBS product, as understood by EPA, physiologically influences the growth and development of plants in such a way as to be considered plant regulators under FIFRA thereby triggering regulation as a pesticide" and that "a key consideration is what claims are being made on product labels." Further, as FIFRA Section 2(v) both defines plant regulator and explains which substances are excluded from the definition, "many PBS products and substances may be excluded or exempt from regulation under FIFRA depending upon their intended uses as plant nutrients (*e.g.*, fertilizers), plant inoculants, soil amendments, and vitamin-hormone products." The draft guidance provides several examples of both product label claims that are considered plant regulator claims and claims that that are not considered plant regulator claims. "Product label claims generally considered 'non-pesticidal' (i.e. non-plant regulator claims)," including: "plant nutrition-based claims"; "plant inoculant-based claims"; and "soil amendment-based claims" (Table 1c).

"Generic product label claims for products not covered by the exclusions in the FIFRA Section 2(v) definition of a plant regulator," including "examples of generic product label claims generally considered by the Agency to be 'non-pesticidal'" (Table 2).

"Plant regulator product label claims that are consistent with the FIFRA Section 2(v) plant regulator definition" including "examples of label claims that are considered … to be plant growth regulator claims that trigger regulation under FIFRA as a pesticide" (Table 3).

"EPA-registered, naturally-occurring, plant regulator active ingredients having modes of action and associated product label claims that are consistent with the FIFRA definition of a plant regulator" (Table 4).

National Law Review, 27 March 2019

http://www.natlawreview.com

States Draft Legislation Following EPA's PFAS Action Plan

2019-03-29

Shortly after the United States Environmental Protection Agency's February 2019 release of its PFAS Action Plan, many states are following suit with draft legislation and other actions addressing per- and polyfluoroalkyl substances (PFAS).

Shortly after the United States Environmental Protection Agency's February 2019 release of its PFAS Action Plan, many states are following suit with draft legislation and other actions addressing per- and polyfluoroalkyl substances (PFAS).

California

The California Water Resources Control Board announced that it will not promulgate an MCL for PFAS in the near term and that it will immediately roll out a "PFAS Phased Investigation Plan" to obtain PFAS effluent and drinking water data across the state. Phase I will require source investigation and sampling at airports, landfills, and drinking water. Phase II will cover refineries, bulk terminals, non-airport fire training areas, and 2017-2018 urban wildfire areas. Phase III will cover secondary manufacturers, wastewater treatment plants and pre-treatment plants, and domestic wells.

Massachusetts

A previous article summarises MassDEP's January 2019 development of a drinking water maximum contaminant level (MCL) for PFAS. MassDEP will focus on a subset of PFAS compounds – PFOA, PFOS, PFHxS, PFHpA, and PFNA – which it describes as compounds that are a threat to human health, are detectable, and can be treated with available technology. MassDEP also acknowledged a plan to develop reportable concentrations and clean-up standards for PFAS under the Massachusetts Contingency Plan.

Michigan

The Michigan legislature introduced three bills that would regulate PFAS. The first House bill would require fire departments to report the use of firefighting foam to the Department of Environmental Quality. A

second House bill would require the promulgation of occupational safety and health rules addressing the use of firefighting foam concentrate containing PFAS in training and equipment calibration, and best practices for proper use, handling and storage of such materials. A third House bill would require firefighters to be trained on these best practices and prohibitions.

Minnesota

The Minnesota House and Senate each introduced bills that would prohibit a person from "manufacturing, knowingly selling, offering for sale, distributing for sale, or distributing for use in Minnesota food packaging to which PFAS have been intentionally added in any amount."

New Jersey

The New Jersey Department of Environmental Protection issued a statewide PFAS directive and information request, which announces a notice of proposed rule amendments concerning PFAS that is to be published in the New Jersey Register on April 1, 2019. The notice will propose establishing MCLs and groundwater quality criteria standards for PFAS, and adding PFAS to the List of Hazardous Substances.

Vermont

A Vermont Senate bill passed by the Senate on 13 March 2019 proposes to adopt a MCL for PFAS under the Agency of Natural Resources' (ANR) Water Supply Rule, and would require interim drinking water testing and monitoring. The bill would also require the adoption of surface water quality standards for PFAS and a statewide investigation of potentials sources of PFAS. The bill's proposed requirement that the ANR report on the management of landfills of leachate containing contaminants of emerging concern is a step down from its initial language, which would have required landfills to treat leachate for PFAS before delivery to a wastewater treatment facility or discharge to the waters of the State.

Wisconsin

Bills introduced in Assembly and Senate would require the Department of Health Services to establish state health-based groundwater quality standards for PFAS.

National Law Review, 27 March 2019

http://www.natlawreview.com

EUROPE

Circularity and innovation key to European chemicals future

2019-03-29

Driving the circular economy is key to the future of the European chemicals industry, the Chemical Watch Global Business Summit has heard. In a keynote address to the two-day event in Brussels, Marco Mensink, Cefic director general, warned that the world is becoming far more fragmented and for the industry to thrive it has to stop complaining about regulatory burden and "develop its own solutions or we're sitting ducks". "With our ageing society, we won't see any less pressure on chemical safety and health. On the contrary, as the work of Echa progresses the pressure will not decrease." This, said Mr Mensink, is a problem because "we don't see this pressure elsewhere in the world". There is a significant difference between the US chemicals regulatory system and Europe's, as well as other countries, and some do not even have the UN's Globally Harmonised System (GHS) for classification and labelling. Fragmentation is breaking the world down into different regions, for example Chinese, African and American worlds, Mr Mensink said. "We need to see what we can do that others can't," he added. "We won't beat the US on shale gas and lawyers, or the Chinese on the number of engineers. So, we have to ask what will be the European thing that drives us forward? "Circularity is key. We have a vast resource in Europe that we're not using today: waste. Make Europe the Bangladesh of the world and recycle every ship we have. Why not massively invest in chemical recycling? Which is what the chemical companies are doing as we speak." Glass, metals and paper have taken the lead and the chemical industry is just catching up, Mr Mensink said. "Chemical recycling will take care of a number of legacy chemicals that we don't know what to do with." Europe must be thought of as a "gigantic source of feedstock".

Investment in chemical recycling underway, says Cefic's Marco Mensink

Integration

And, he said, the industry should look at integrating its operations with other sectors, for example steel production where waste gases could become a 'feedstock' for chemical companies. "Today we have 30 companies working on chemical recycling across Europe." "We want to be the canary that survives the coal mine," Mr Mensink concluded, calling on Europe to lead the way across the globe with "new kinds of chemistry, new kinds of waste, and engaging in a lot of debates". At last year's Helsinki

Chemicals Forum, Mr Mensink called for a "smart REACH foreign policy". Cefic will be launching its mid-century strategy on 25 June.

Chemical Watch, 27 March 2019

http://chemicalwatch.com

PFAS cost to EEA health estimated at up to €84bn – report

2019-03-29

The impact of per-and polyfluoroalkyl substances (PFASs) on human health in the European Economic Area (EEA) could cost between €52 and €84bn a year, a report commissioned by the Nordic Council of Ministers estimates. The report, *The cost of inaction – a socioeconomic analysis of environmental and health impacts linked to exposure to PFAS*, focused on estimated costs that arise from a lack of proper regulatory controls. Costs of inaction are defined as those society will pay in the future if steps are not taken now to limit emissions, the report says. Milieu Consulting carried out the study for the Nordic Council, which is an official body for formal inter-parliamentary cooperation among the Nordic countries. PFASs, used to make nonstick, waterproof and grease-resistant materials, are highly bioaccumulative and suspected to be harmful to humans and the environment. Exposure occurs primarily through contamination of drinking water, but also their use in consumer goods such as pizza boxes, clothes and cosmetic products. Potential health problems from exposure, as outlined in the report, include kidney cancer in workers at chemical production plants or manufacturing sites and low birth weight in children born in communities near chemical plants. The project aimed to provide better awareness of the costs and long-term problems associated with PFAS exposure and help the authorities, policy makers and the general public when it comes to considering effective risk management. "PFASs have been found in the environment all around the world and almost everyone living in a developed country has one or more in his/her body," the report says. The two most cited studies are from the US and Denmark, co-author Gretta Goldenman told Chemical Watch. The former detected the substances in over 98% of samples taken in 2003-2004 from the general US population aged 12 or over. The latter from 2015 analysed blood samples from 116 children aged six to 11 and 143 mothers for six PFASs and found all to be above the detection limit except for PFHxS in one child.

Nordic Council of Ministers project looks at workers and general population

Estimates of annual health-related costs from PFAS exposure

Exposure level	'Exposed' population and source	Health endpoint	EEA population at risk	EEA annual costs
Occupational (high)	Workers at chemical production plants or manufacturing sites	Kidney cancer	84,000-273,000	€12.7-41.4m
Elevated (medium)	Communities near chemical plants, etc with PFAS in drinking water	All-cause mortality	12.5m	€41-49bn
		Low birth weight	156,344 births	3,354 births of low weight
		Infection	785,000 children	1.5m additional days of fever
Background (low)	Adults in general population (exposed via consumer products, background levels)	Hypertension	207.8m	€10.7-35bn
Total				€52-84bn

Source: *The cost of inaction – a socioeconomic analysis of environmental and health impacts linked to exposure to PFAS*

Methodology

Due to the "underlying uncertainty" about the current health impacts from PFASs, the study selected endpoints for which there is considerable consensus, Ms Goldenman said. The health-related cost estimates were constructed using scientific evidence concerning the chosen adverse health endpoints, under the following scenarios:

- exposure level in workers at chemical production or manufacturing sites (subject to high exposure);
- people living near chemical plants (subject to medium exposure); and
- the general population (subject to low exposure).

Regulatory Update

"We would like to emphasise [...] that more research on the health impacts is needed, particularly in the European context," Ms Goldenman added. The report suggests the following could help to fill knowledge gaps:

- consideration of health endpoints as a result of exposure to groups of PFASs, since exposures are rarely limited to a single substance PFAS and they share similar properties;
- more information on production sites. National inventories are needed to help gauge the number of affected populations and the extent of contamination where remediation may be needed;
- systematic cataloguing of cost data where problems have been identified;
- inclusion of industries producing or using the chemicals in the European Pollutant Release and Transfer Register to enable tracking of releases;
- national registries of products containing PFASs to help inform how they are used and to contribute to better characterisation of the major sources of exposure from them; and
- more biomonitoring and epidemiological studies to characterise links between exposure and health endpoints to enable better calculations of associated health costs.

EU activity

In February last year, the European Commission adopted a proposal for a revised drinking water Directive, which included limit values for PFASs. And, in July, the Nordic Council called for an amendment of the drinking water and groundwater Directives to establish limits for the chemicals as well as monitoring obligations. It also said that a global regulation would be the best option, but that, considering the time required, "existing EU regulatory tools can be used and further developed". Further information is available at:

- Nordic council report
- Nordic council press release
- US study
- Danish study

Chemical Watch, 28 March 2019

http://chemicalwatch.com

Regulatory Update

ECHA to recommend occupational exposure limits (OELs)

2019-03-29

After the European Chemicals Agency's (ECHA) Risk Assessment Committee (RAC) has taken over the work from the Scientific Committee of Occupational Exposure Limits (SCOEL), ECHA will from 2020 and onwards give recommendations for 4-5 occupational exposure limits (OELs) per year. This follows the agreement between ECHA and the European Commission to ensure coherence in the regulatory guidelines for protection of workers exposed to hazardous chemicals in the workplace. RAC will review and adopt scientific opinions on OELs, which will then be submitted to the Commission for further decision. Through public consultations ECHA will ensure a transparent process. The first substances to be evaluated with a view to provide recommendations for OELs are lead and its compounds and diisocyanates.

DHI Newsletter, 28 March 2019

http://www.dhigroup.com

Danish workplace instructions on hazardous chemicals to terminate

2019-03-29

As of 1 July 2019, the Danish requirement for written workplace instructions for hazardous chemicals will no longer be mandatory. In the future, the employer must make sure that staff working with hazardous chemicals receives oral instructions in the safe use of the chemicals. The instructions must include information on exposure limit values, curing time for epoxy and isocyanate products, use of personal protective equipment, disposal of waste etc. These instructions must be based on the mandatory workplace risk assessment.

DHI Newsletter, 28 March 2019

http://www.dhigroup.com

After the European Chemicals Agency's (ECHA) Risk Assessment Committee (RAC) has taken over the work from the Scientific Committee of Occupational Exposure Limits (SCOEL), ECHA will from 2020 and onwards give recommendations for 4-5 occupational exposure limits (OELs) per year.

REACH Update

Enforcement authorities to focus on evaluation decisions

2019-03-29

With an increased focus on evaluation and an expected increase in the number of decisions, the European Chemicals Agency (ECHA) has invited enforcement authorities to prioritise the enforcement of evaluation decisions. Since 1 January 2019, when checking the compliance of registration dossiers for substances ECHA has been addressing its evaluation decisions to all registrants with non-compliant dossiers. This was a change from the previous practice of mainly addressing lead registrants. Inspectors have effectively enforced ECHA's decisions since 2013. ECHA has now invited the enforcement authorities to prioritise the evaluation decisions in their enforcement activities. The Forum also agreed to start a pilot to voluntarily report annual national enforcement activities to the Agency. This will support the planning and prioritisation of the Forum's activities. This annual reporting would be done in addition to the mandatory reports, which the Member States submit to the Commission every five years. A template will be prepared and sent to national enforcement authorities. After the pilot phase, the Forum will decide whether the practice of annual reporting of enforcement related activities will continue. Finally, the Forum's Biocidal Products Regulation (BPR) subgroup agreed to work together with the Biocidal Products Committee (BPC) to test whether national enforcement authorities can provide advice on the enforceability of risk mitigation measures that are proposed by the BPC for applications for approval of active substances and Union authorisations of biocidal products. The Forum for exchange of information on enforcement and its BPR subgroup met in Helsinki on 19-22 March 2019.Further information is available at:

- Enforcement Forum
- Member registrants will start receiving dossier evaluation decisions in 2019

ECHA, 26 March 2019

http://echa.europa.eu

With an increased focus on evaluation and an expected increase in the number of decisions, the European Chemicals Agency (ECHA) has invited enforcement authorities to prioritise the enforcement of evaluation decisions.

ECHA's Brexit window to stay open beyond 30 March

2019-03-29

The European Council has changed the UK withdrawal date to either 12 April or 22 May 2019. The European Chemicals Agency (ECHA) advises companies to continue their preparations for the UK withdrawal without a

transition period. Respectively, the 'Brexit window' will stay open beyond the 30 March, subject to further developments. The European Council decided that the UK withdrawal date will be either 12 April 2019 or 22 May 2019. Which of these dates apply, will depend on a further vote of the House of Commons on the draft Withdrawal Agreement that the European Council endorsed on 25 November 2018. ECHA will amend its advice in accordance with further developments. Meanwhile, previous advice and instructions for companies published by ECHA remain valid. Since the beginning of this year, UK-based companies have initiated the transfer of approximately 3 000 registrations to EU-27 companies. Further information is available at:

- UK's withdrawal from the EU
- Advice to companies

ECHA, 25 March 2019

http://echa.europa.eu

Registrants: get ready to comment on the 2018 substance evaluation draft decisions

2019-03-29

On 18 April, the European Chemicals Agency (ECHA) will send out 11 draft decisions on information requests to registrants for comments.

On 18 April, the European Chemicals Agency (ECHA) will send out 11 draft decisions on information requests to registrants for comments. The registrants will have 30 days to submit their comments. The decisions are on substances evaluated by Member States in 2018 on which further information is required to clarify the identified concerns. ECHA recommends that one representative send consolidated comments on behalf of all addressed registrants of a substance. The conclusion documents with possible indications for further regulatory action will soon be published on ECHA's website. Further information is available at:

- Substance evaluation outcomes 2018
- Practical guide – how to act in substance evaluation
- CoRAP table
- Substance evaluation web pages

ECHA News, 27 March 2019

http://echa.europa.eu

REACH Update

New proposals and intentions to harmonise classification and labelling

2019-03-29

The European Chemicals Agency (ECHA) has announced that 2 new proposals and 1 intention to harmonise classification and labelling has been submitted. The proposals have been submitted for:

- benzophenone (EC 204-337-6, CAS 119-61-9); and
- divanadium pentaoxide (EC 215-239-8, CAS 1314-62-1).

One intention has also been received for cumene (EC 202-704-5, CAS 98-82-8). Further information is available at: Registry of CLH intentions until outcome

ECHA News, 27 March 2019

http://echa.europa.eu

The European Chemicals Agency (ECHA) has announced that 2 new proposals and 1 intention to harmonise classification and labelling has been submitted.

New format for reporting of exposure data by downstream users

2019-03-29

The European Chemicals Agency's (ECHA) new format helps downstream users of authorised substances report occupational exposure measurements or biomonitoring data related to the tasks performed at their sites. The format aims to ensure that exposure information provided in review reports or initial applications for authorisation covering several sites downstream is of high quality. The availability of such exposure information will also enable industry to better evaluate the appropriateness and effectiveness of current risk management measures. Further information is available at:

- Format
- Submitting downstream user notification of authorised uses

ECHA News, 27 March 2019

http://echa.europa.eu

Authorisations granted for uses of three substances

2019-03-29

The European Commission has granted authorisations (expiry date of review period in brackets) for:

REACH Update

- two uses of chromium trioxide (EC 215-607-8, CAS 1333-82-0) to Federal-Mogul Friedberg GmbH (21 September 2029) - details use 1 and use 2;
- one use of sodium dichromate (EC 234-190-3, CAS 10588-01-9) to Borealis Plastomers B.V (21 September 2029) - details; and
- for two uses of 1,2-dichloroethane (EC 203-458-1, CAS 107-06-2) to OLON Spa (22 November 2029) - details use 1 and use 2.

Further information is available at: Adopted opinions and previous consultations on applications for authorisation

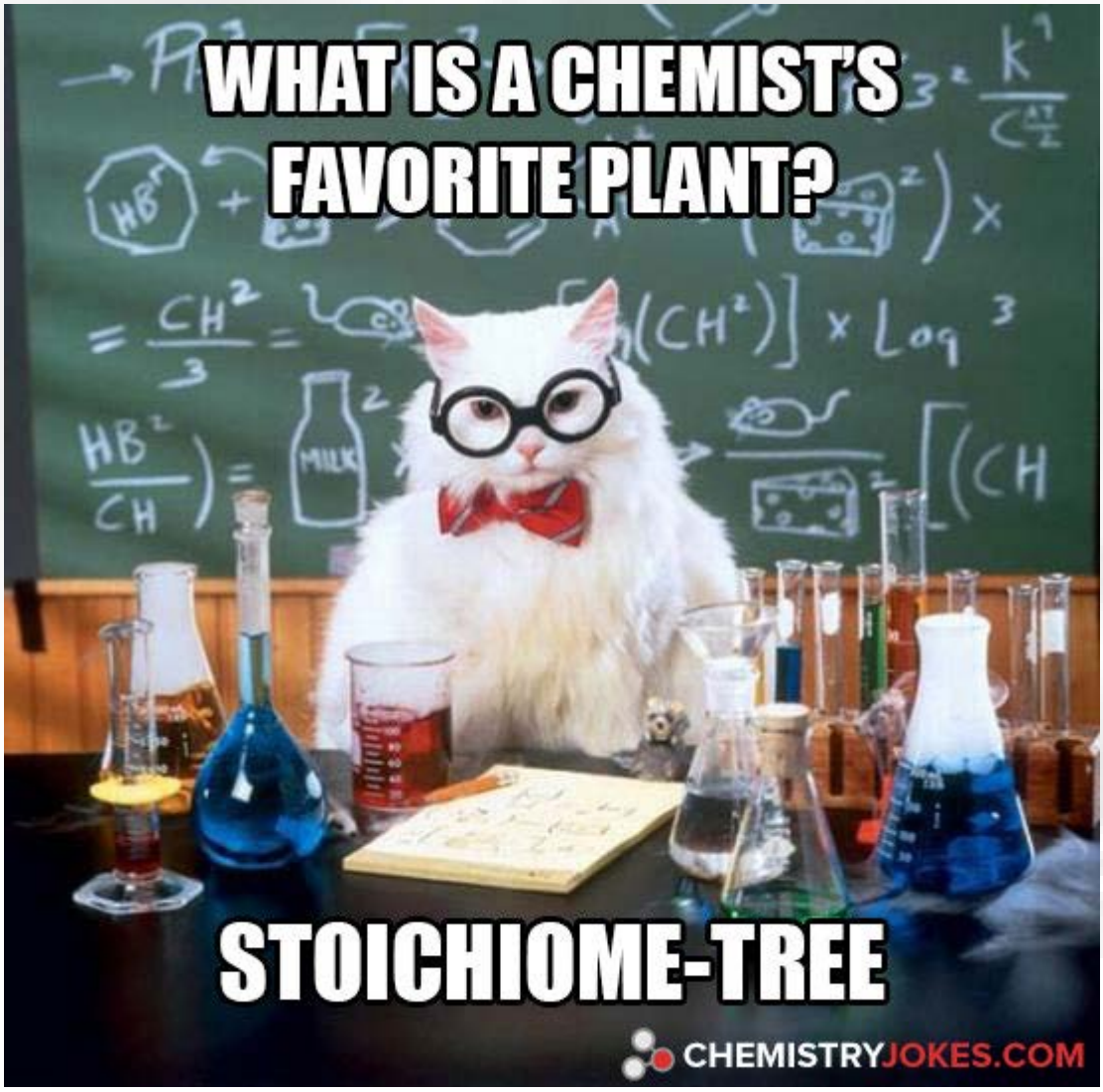
ECHA News, 27 March 2019

http://echa.europa.eu

Janet's Corner

Favourite Plant

2019-03-29



Hazard Alert

CHEMWATCH

Hexachlorobenzene

2019-03-15

Hexachlorobenzene (HCB), is a chlorocarbon with the molecular formula C_6Cl_6. [1] It is a fully chlorinated industrial hydrocarbon chemical, which is insoluble in water, but is very soluble in fat, oils, and organic solvents. Hexachlorobenzene is one of the most persistent environmental pollutants, and bioaccumulates in the environment, in animals, and in humans. It is not currently manufactured as a commercial product in the United States, and virtually all commercial production ended in the late 1970s. However, some hexachlorobenzene is produced as a by-product or impurity in the manufacture of chlorinated solvents and other chlorinated compounds, including several pesticides currently in use (pentachloronitrobenzene, chlorothalonil, Dacthal®, picloram, pentachlorophenol, atrazine, simazine, and lindane). [2] HCB has been banned globally under the Stockholm Convention on persistent organic pollutants. [1]

USES [3]

Hexachlorobenzene (HCB), is a chlorocarbon with the molecular formula C6Cl6.

There are currently no commercial uses of hexachlorobenzene. It was previously used as a pesticide but is no longer registered for this use. In addition, HCB was used in the production of fireworks, ammunition, rubber, aluminium, and dyes, and in wood preservation. Hexachlorobenzene was widely used as a pesticide to protect the seeds of onions and sorghum, wheat, and other grains against fungus. It is formed as a by-product during the manufacture of chemicals used as solvents (to dissolve other substances), other chlorine-containing compounds, and pesticides. Furthermore, it is formed as a by-product in the waste streams of chloralkali and wood-preserving plants, and when burning municipal waste.

HCB IN THE ENVIRONMENT [4]

- Hexachlorobenzene can remain in the environment for a long time.
- It breaks down very slowly.
- It does not dissolve in water very well, so most of it will remain in particles on the bottom of lakes and rivers.
- Hexachlorobenzene sticks strongly to soil.
- High levels can build up in fish, marine mammals, birds, lichens, and animals that eat lichens (like caribou) or fish.

- It can also build up in wheat, grasses, some vegetables, and other plants.

SOURCES & ROUTES OF EXPOSURE

Sources of Exposure [4,5]

- Inhalation exposure to hexachlorobenzene may occur through proximity to industrial sites where it is formed as a by-product or to waste facilities where it is disposed.
- Occupational exposure, via inhalation and dermally, can occur at industries where hexachlorobenzene is produced as a by-product.
- Exposure to hexachlorobenzene can also occur through consuming foods tainted with hexachlorobenzene including fish and dairy products or meat from cattle grazing on contaminated pastures.
- Drinking small amounts in contaminated water.
- Eating or touching contaminated soil.
- For babies, drinking contaminated breast milk from exposed mothers.
- Hexachlorobenzene has been listed as a pollutant of concern to EPA's Great Waters Program due to its persistence in the environment, potential to bioaccumulate, and toxicity to humans and the environment

Routes of Exposure [6]

- Inhalation – A minor route of exposure for the general population.
- Oral – The predominant route of exposure for the general population through ingestion of contaminated food.
- Dermal – Skin contact with contaminated soil may be an important route of exposure, for those living near waste sites, especially children

HEALTH EFFECTS [5]

Acute Effects

- No information is available on the acute (short-term) effects of hexachlorobenzene in humans.
- Acute animal tests in rats and mice have shown hexachlorobenzene to have low-to-moderate acute toxicity from oral exposure.

Chronic Effects

- Humans who ingested hexachlorobenzene in heavily contaminated bread during a 4-year poisoning incident were sickened with a liver disease with associated skin lesions (porphyria cutanea tarda).
- Very little data is available on the health effects of hexachlorobenzene in humans or animals following inhalation exposure.
- Animal studies have reported effects on the liver, skin, immune system, kidneys, and blood from chronic oral exposure to hexachlorobenzene.
- EPA has determined that there is inadequate data to establish a Reference Concentration (RfC) for hexachlorobenzene.
- The California Environmental Protection Agency (CalEPA) has established a chronic inhalation reference exposure level of 0.003 milligrams per cubic metre (mg/m^3) for hexachlorobenzene.
- The Reference Dose (RfD) for hexachlorobenzene is 0.0008 milligrams per kilogram body weight per day (mg/kg/d) based on liver effects in rats.

Reproductive/Developmental Effects

- One human study reported abnormal physical development in young children who ingested contaminated bread during a 4-year poisoning incident.
- Hexachlorobenzene has been found to decrease the survival rates of newborn animals and to cross the placenta and accumulate in foetal tissue in several animal species.
- Neurological, teratogenic, liver, and immune system effects have been reported in the offspring of animals orally exposed to hexachlorobenzene while they were pregnant.

Cancer Risk

- Human data regarding the carcinogenic effects of hexachlorobenzene are inadequate.
- Hexachlorobenzene, when administered orally, has been shown to induce tumours of the liver, thyroid, and kidney in several animal species.
- EPA has classified hexachlorobenzene as a Group B2, probable human carcinogen.
- EPA calculated an inhalation unit risk estimate of 4.6×10^{-4} $(\mu g/m^3)^{-1}$.

SAFETY [7]

First Aid Measures

- Eyes: Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid.
- Skin: Flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Get medical aid.
- Ingestion: If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid.
- Inhalation: Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Exposure Controls & Personal Protection

Engineering Controls

Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Personal Protective Equipment

- Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
- Skin: Wear appropriate protective gloves to prevent skin exposure.
- Clothing: Wear appropriate protective clothing to prevent skin exposure.
- Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

REGULATION

United States [4,8]

- The EPA has recommended that drinking water should not contain more than 0.05 milligrams of hexachlorobenzene per litre of water (0.05 mg/L) in water that children drink, and should not contain more than 0.2 mg/L in water that adults drink for longer periods (about 7

years). The EPA has set a maximum contaminant level of 0.001 mg/L in drinking water.

- The EPA requires that spills or accidental releases into the environment of 10pounds or more of hexachlorobenzene be reported to the EPA.
- ACGIH: The American Conference of Governmental Industrial Hygienists has set a time weighted average threshold limit value (TLV) of 0.002 mg/m^3; Skin; Appendix A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans

Australia [3]

- No national guidelines.

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Gossip

New antibiotic named after Leiden

2019-03-12

Increasing resistance and a lack of new antibiotics are a serious problem for public health. Against this background, Gilles van Wezel of the Institute of Biology Leiden is looking for new medicines. Together with former Ph.D. student Changsheng Wu and colleagues he discovered the special antibiotic lugdunomycin, which they named after Leiden. The discovery was recently published in the journal Angewandte Chemie. "It is predicted that by 2050 approximately 10 million people worldwide will die from the consequences of antibiotic resistance," says Van Wezel. "That is as many as due to cancer. We are facing a negative trend in which more and more bacteria are becoming resistant, often to multiple antibiotics, while at the same time fewer and fewer new medicines are coming onto the market. We want to find solutions for this." Van Wezel performs research into the bacterium Streptomyces. This genus lives in the soil and produces no less than two-thirds of all antibiotics. Because they have been used and screened for so long, the pharmaceutical industry thought that everything that could be obtained from these bacteria had already been discovered. The source seemed exhausted," says Van Wezel. But that turned out not to be the case after all. At the beginning of the 21st century, DNA sequencing took off: a technique for visualising and analysing the entire DNA of organisms. "This way we could also look at the DNA of antibiotic-producing bacteria. Then it turned out that they had much more potential than we had previously thought possible! The Streptomyces coelicolor model strain, which produces sky blue (coelicolor in Latin) antibiotics, is a good example. The bacterium produces as many as four different species. Thousands of scientists have been working on this strain for fifty years, so it was thought that there was not much more to be obtained. However, when the complete DNA of the strain was published in 2002, it appeared that the DNA of the bacteria contains far more recipes for antibiotics than just for the antibiotics they produce in the lab. These are called sleeping antibiotics. It takes a bacterium a lot of energy to make antibiotics," explains Van Wezel. "That's why they don't do it when it's not necessary." Therefore, in the laboratory bacteria make fewer antibiotics than in the soil. Simply because the lab lacks the necessary ecological conditions. "Or, in other words: in the soil, there are more enemies against which bacteria need antibiotics."

Lugdunomycin is derived from a well-known family of molecules with mainly anti-tumour activity but underwent such large modifications that it no longer looks like it.

Leiden antibiotic

The antibiotic discovered by Wu, Van Wezel and co-promoter Young Hae Choi is also a sleeping antibiotic, produced by a still unknown

Gossip

Streptomyces bacterium from the Qinling Mountains in China. They called it lugdunomycin, after the Latin name for Leiden (Lugdunum batavorum). "Wu has looked at a strain that did not produce anything at first sight. But after imitating different growing conditions, we nevertheless witnessed biological activity here. This led to the discovery of a chemical molecule with an unforeseen complex structure!" Lugdunomycin is derived from a well-known family of molecules with mainly anti-tumour activity but underwent such large modifications that it no longer looks like it. "The addition of three extra rings make it look like a helicopter," says Van Wezel. "We have never seen this before, but it will certainly occur more often in nature. But in such small quantities that they must have been overlooked until now." The discovery of such a radically different chemical structure is rare. Now that Wu, Choi and Van Wezel have published the structure of lugdunomycin, the next challenge is: to make Streptomyces produce more of it. They also have to investigate the exact activity of the molecule, and whether it is actually clinically applicable. Possibly, the Leiden antibiotic will be able to serve as real medicine in the future. To this end, Van Wezel started a follow-up project within the NACTAR programme in the NWO domain of Applied and Technical Sciences (TTW). In this program, scientists and industry work together on the development of new antibiotics. "For now, at least, we have discovered this special molecule, which is very exciting. I don't think we will quickly discover another molecule with such a spectacular structure."

Phys.org, 1 March 2019

http://phys.org

Three people were taken to hospital following a chemical spill at the Australian Nuclear Science and Technology Organisation facility at Lucas Heights recently.

Spill at a nuclear facility shows potential burn risks from a household chemical

2019-03-12

Three people were taken to hospital following a chemical spill at the Australian Nuclear Science and Technology Organisation facility at Lucas Heights recently. Despite the Sydney site's notoriety as home to Australia's only nuclear reactor, the ANSTO said the spill involved "approx 250mL of sodium hydroxide", a substance that does not contain radioactive material. Sodium hydroxide can be bought at many supermarkets or hardware stores for less than A$10 a kilogram. Most people will have used sodium hydroxide (NaOH - commonly known as caustic soda or lye) at some point in their life, either in chemistry classes at school or as a strong cleaning agent in the home. The chemical also has many other uses as varied as cleaning drains, making soap, and producing rocket fuel. Even though the

chemical is easily available, it can still be dangerous. At room temperature, NaOH is a white solid that looks something like its close relative table salt (NaCl – sodium chloride). It dissolves readily in water, in a process that causes the mixture to heat up. In many industrial uses, such as the one in the incident at Lucas Heights, the NaOH is dissolved in water and used as such. Solid NaOH should not be handled with bare skin. Any water on the skin (such as sweat), will dissolve some of the solid NaOH, creating a very concentrated solution directly in contact with the skin. The chemistry of what happens when NaOH comes into contact with the skin is not dependent upon the concentration of material. The only thing that happens if there is more NaOH is that the reactions happen faster, thus causing more damage, more quickly.

Not just chemical burns

The main danger from skin contact is that the sodium hydroxide reacts with the fats (and proteins) that make up the outside of the cells in skin. This reaction has two effects. One is the obvious fact that if the cell membranes break down, the cells die. The other is, just like dissolving in water, the reaction with the membranes gives out heat. This reaction is known as saponification – a process for making soap. If you've ever spilled a dilute solution of sodium hydroxide on your skin, and then washed it off with water, you've probably been surprised by the soapy sensation of the process. The reaction of the NaOH with your skin literally produces soap. In small quantities on the outer layer of skin, this is not particularly dangerous, but in concentrated form, the reaction can very quickly burn a hole through the skin and into the tissue beneath. Anyone who has seen the 1999 movie Fight Club will know how painful that can be. But this process of dissolving otherwise insoluble fats is the main household use for sodium hydroxide. When mixed with the fats that sometimes deposit in drains, the sodium hydroxide reacts to turn them into water soluble soap, which can then be washed away.

Treat like any other burn

The treatment for almost all burns is the same. Remove the source of the burn (in this case the sodium hydroxide) and then flush the affected area for 20 minutes with cold running water. In the case of a chemical burn, using copious amounts of running water will quickly dilute and wash away the cause of the burn. If the victim has the burning chemical on their clothing, try to cut off the clothing rather than pull it off over the head, risking spreading the chemical to unaffected parts of the patient.

Accidents do happen

Gossip

We are often surrounded by chemicals that pose potential serious dangers if incorrectly handled. This is doubly true for many industrial sites. For this reason, we should be aware of their presence in our environment, the hazards that they pose, how to handle them safely, and how to respond correctly in the event of a spillage or contact with the body. The three staff members at Lucas Heights were reportedly taken to the nearby Sutherland Hospital and were said to be in a stable condition.

Phys.org, 1 March 2019

http://phys.org

EU food agency must release glyphosate studies: court

2019-03-12

The European Food Safety Agency (EFSA) must disclose details of studies on the toxicity and carcinogenic properties of glyphosate, EU judges ruled recently, cheering campaigners who want the weedkiller banned. In a statement, the European Court of Justice's General Court said the public interest in accessing the information related not only to knowing what is or could be released into the environment, but to understanding the impact of those emissions. Judges annulled two decisions by EFSA that denied access to details of the studies into the substance, which campaigners say should be banned. The two cases were brought by Green members of the European Parliament among others. "EFSA welcomes the decision," the agency's spokesman said in a statement. "This case, and the Court's ruling, is important because it provides orientation for EFSA and others charged with interpreting EU legislation on public access to documents." Glyphosate was developed by Bayer's Monsanto under the brand Roundup. It is now off-patent and marketed worldwide by dozens of other chemical groups including Dow Agrosciences and Germany's BASF. Concerns about its safety were highlighted when a World Health Organization agency concluded in 2015 that it probably causes cancer. In 2017, President Emmanuel Macron pledged to ban glyphosate in France within three years, rejecting a European Union decision to extend its use for five years.

The European Food Safety Agency (EFSA) must disclose details of studies on the toxicity and carcinogenic properties of glyphosate, EU judges ruled recently, cheering campaigners who want the weedkiller banned.

Reuters Health, 7 March 2019

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

Gossip

Melting Glass Experiment Surprises Scientists by Defying a Law of Electricity

2019-03-12

A team of scientists working with electrical currents and silicate glass have been left gobsmacked after the glass appeared to defy a basic physical law. If you pass an electrical current through a material, the way that current generates heat can be described by Joule's first law. It's been observed time and time again, with the temperature always evenly distributed when the material is homogeneous (or uniform). But not in this recent experiment. A section - and only a section - of silicate glass became so hot that it melted, and even evaporated. Moreover, it did so at a much lower temperature than the boiling point of the material. The boiling point of pure silicate glass is 2,230 degrees Celsius (4,046 degrees Fahrenheit). The hottest temperature the researchers recorded in a homogeneous piece of silicate glass during the experiment was 1,868.7 degrees Celsius. Say whaaaat. "The calculations did not add up to explain what we were seeing as simply standard Joule heating," said engineer and materials scientist Himanshu Jain of Lehigh University. "Even under very moderate conditions, we observed fumes of glass that would require thousands of degrees higher temperature than Joule's law could predict!" Jain and his colleagues from materials science company Corning Incorporated were investigating a phenomenon they had described in a previous paper. In 2015, they reported that an electric field could reduce the temperature at which glass softens, by as much as a few hundred degrees. They called this "electric field-induced softening." It was certainly a peculiar phenomenon, so they set up another experiment. They put pieces of glass in a furnace, and applied 100 to 200 volts in the form of both alternating and direct currents. Next, a thin wisp of vapour emanated from the spot where the anode conveying the current contacted the glass. "In our experiments, the glass became more than a thousand degrees Celsius hotter near the positive side than in the rest of the glass, which was very surprising considering that the glass was totally homogeneous to begin with," Jain said. This seems to fly in the face of Joule's first law, so the team investigated more closely - and found that the glass wasn't remaining as homogeneous as it started out. The electric field changed the chemistry and the structure of the glass on nanoscale, in just a small section close to the anode. This region heats faster than the rest of the glass, to the point of becoming a thermal runaway - where an increase in temperature further increases temperature in a blistering feedback loop. As it turned out, that spot of structural change and dramatic heat resulted in a small area of glass reaching melting point while the rest of the material remained

A team of scientists working with electrical currents and silicate glass have been left gobsmacked after the glass appeared to defy a basic physical law.

solid. "Unlike electronically conducting metals and semiconductors, with time the heating of ionically conducting glass becomes extremely inhomogeneous with the formation of a nanoscale alkali-depletion region, such that the glass melts near the anode, even evaporates, while remaining solid elsewhere," the researchers wrote in their paper. In other words, the material wasn't homogeneous any more, which means the glass heating experiment doesn't exactly change how we apply Joule's first law. But it's an exciting result, since until now we didn't know a material could actually lose its homogeneity with the application of an electrical current. (The thing is, no one had tried electrically heating glass to these extreme temperatures before.) So, the physical laws of the Universe are still okay, as a piece of glass hasn't broken them. But Joule's first law may need a bit of tweaking to take this effect into account. And, of course, it's another piece of understanding that could help us in other ways too. "Besides demonstrating the need to qualify Joule's law," Jain said, "the results are critical to developing new technology for the fabrication and manufacturing of glass and ceramic materials." The research has been published in Scientific Reports.

Science Alert, 11 March 2019

http://www.sciencealert.com.au

This Lab Has Built a Prototype 'Anti-Laser' That Swallows Light

2019-03-12

Researchers have published a study that explores the blueprint for building an anti-laser that's more complex than anything we've seen before.

In recent years scientists have started exploring the concept of anti-lasers - devices that can perfectly absorb a particular wavelength of light, as opposed to emitting it the way a laser does. Now researchers have published a study that explores the blueprint for building an anti-laser that's more complex than anything we've seen before. More than an anti-laser, this team's device is a 'random anti-laser': capable of absorbing waves randomly scattered in all directions. This ability could have a variety of potential uses, in everything from phone antennas to medical equipment – anywhere waves are captured. An anti-laser may sound wild, but it's actually pretty much what it says on the tin. You can think of such a device as a laser light burst happening in reverse - getting swallowed up rather than beamed out, according to the researchers. "So far, anti-lasers have only been realised in one-dimensional structures onto which laser light was directed from opposite sides," says one of the team, Stefan Rotter from the Vienna University of Technology in Austria. "Our approach is much more general: we were able to show that even arbitrarily

complicated structures in two or three dimensions can perfectly absorb a suitably tailored wave. In this way, this novel concept can also be used for a much wider range of applications." It's that versatility and flexibility that sets this new anti-laser apart from what previous such devices. The team worked up a set of calculations and computer simulations to theorise how such a perfectly absorbing anti-laser might work, then backed them up with physical lab tests. Key to the process is finding a wave front for the incoming signals in order to perfectly absorb them. That then enables the absorption of waves that aren't arriving in predictable ways, but rather as scattered signals bouncing in from multiple sources. "Waves that are being scattered in a complex way are really all around us – think about a mobile phone signal that is reflected several times before it reaches your cell phone," says Rotter. "This multiple scattering is made practical use of in so-called random lasers. Such exotic lasers are based on a disordered medium with a random internal structure that can trap light and emit a very complicated, system-specific laser field when supplied with energy." When it came to building their own anti-laser, the scientists set up a series of randomly placed Teflon cylinders, and sent microwave signals scattering through them – a little bit like rocks deflecting water waves in a puddle of water. A waveguide placed on top with an antenna in its centre was used to absorb the incoming waves. The researchers managed to get an absorption rate of approximately 99.8 percent of the signals they broadcast. That high mark is only in tightly controlled conditions, though – the team first measured the wave reflections as they came back in order to finely tune the central antenna to absorb them. Both the frequency of the signal and the absorption strength have to be carefully calibrated. As a first attempt though, it's very promising, and the theoretical physics behind the project suggests it can be adapted to a range of other signals and applications. It could work for any scenario "in which waves need to be perfectly focused, routed or absorbed", write the researchers. "Imagine, for example, that you could adjust a cell phone signal exactly the right way, so that it is perfectly absorbed by the antenna in your cell phone," says Rotter. "Also, in medicine, we often deal with the task of delivering wave energy to a very specific point – such as shock waves shattering a kidney stone." Being treated with an anti-laser sounds pretty cool to us. The research has been published in Nature.

Science Alert, 8 March 2019

http://www.sciencealert.com.au

Gossip

Zero-emission diesel combustion using a non-equilibrium-plasma-assisted MnO2 filter

2019-03-12

Diesel engines are widely used in agricultural machinery, vehicles, and ships because of their high thermal efficiency. The sulfur contained in the diesel fuel is oxidised to sulfur dioxide by combustion. This sulfur dioxide not only harms human health but also causes deactivation of the catalysts used to treat NOx in the exhaust stream. This problem can be overcome by using sulfur-free fuels based on biomass or clean coal technology or by installing a desulfurizing filter to remove sulfur oxides upstream of the NOx catalyst. Researchers at Kanazawa university have developed a plasma-assisted MnO2 filter that produces exhaust free of NOx and SOx. This technology augments the desulfurization properties of MnO2 with the activity of ozone from an atmospheric-pressure non-equilibrium plasma. Activated chemical species (O3, OH radicals, etc.) present in the plasma promote desulfurization and denitration reactions. MnO2 reacts with sulfur and nitrogen oxides to produce sulfates and nitrates, respectively. The interaction between SO2 and NO2 degrades the performance of MnO2 catalysts in eliminating both species. Prof Huang of the Guangzhou Institute of Energy Conversion analysed the MnO2 catalyst material after exposure to simulated exhaust gas containing both SO2 and NO2 and found that both manganese nitrate and manganese sulfate were produced. We evaluated the impact of ozone on the performance of the catalyst for SO2 and NO2 removal. An atmospheric-pressure non-equilibrium plasma was generated by the dielectric barrier discharge method. The performance of the catalyst in eliminating both SO2 and NO2 was improved by the introduction of ozone at a low concentration of about 50 ppm. The enhancement in NO2 elimination was particularly notable. The introduction of ozone seems to give a reaction to reduce nitrogen oxides to nitrogen. At the initial stage of the reaction, over 99% of SO2 and NO2 were removed from the exhaust stream. The Kanazawa University researchers, led by Yugo Osaka, demonstrated for the first time that zero emissions of NOx can be achieved even in the presence of sulfur oxides by using a plasma-assisted MnO2 filter. The plasma-assisted filter seems to augment the elimination of SO2 because of SO3 generation and also reduce nitrogen oxides to nitrogen. These findings are expected to be widely applicable in the purification of exhaust from diesel engines using sulfur-containing fuels. We have clarified the mechanism by which the induction of the non-equilibrium plasma augments the performance of the MnO2 filter. We hope to spur further development of plasma-assisted

Engineers have used ozone from an atmospheric-pressure non-equilibrium plasma together with the desulfurization catalyst MnO2 to almost completely eliminate NOx and SOx from diesel exhaust gas at a low temperature of 473 K.

MnO2 filters and thus allow for a greater diversity of fuels to be used without adversely impacting air quality.

Science Daily, 7 March 2019

http://www.sciencedaily.com

How antifreeze proteins make ice crystals grow

2019-03-12

Bacteria, plants, insects, or even fish use antifreeze proteins to protect themselves from the cold. The proteins block the growth of ice crystals. In a new study, a German-Israeli research team has confirmed that these proteins also possess an unusual second property: at low temperatures, they can promote rather than inhibit the growth of ice crystals. The study brought together researchers from Bielefeld University, the Hebrew University of Jerusalem, and the Weizmann Institute of Science in Rehovot (Israel). It is being published March 7, 2019 in the Journal of Physical Chemistry Letters. "We are studying how special, naturally occurring proteins influence the smallest of ice crystals -- the crystal embryos," says Professor Dr Thomas Koop. The chemist heads Bielefeld University's 'Atmospheric and Physical Chemistry' research group. "Normally, such proteins ensure that crystal embryos are neutralized and do not grow into large ice crystals." That, for example, is essential for the survival of the larvae of the mealworm beetle. They use a protein to protect their skin and body fluids from being damaged by ice crystals. When the outside temperature drops, the larvae secrete an antifreeze protein into their body fluids. The protein molecules cover the surface of the crystal embryos, thereby preventing them from growing large enough to damage the cells. "There are many other organisms in contrast, that can benefit from making water turn into ice," says Koop. This is the case with, for example, bacteria that trigger the formation of ice. They secrete proteins on which crystal embryos can form, or nucleate from the cold liquid water, and thereafter grow into large ice crystals. Bacteria can use this, for example, to split open the skin of a tomato. Until now, science has viewed ice-promoting and ice-inhibiting proteins as two different types of protein. That is also indicated by their different sizes: ice-inhibiting proteins are made up of small molecules; ice-promoting proteins, of large long molecules. However, the new experiments show that, "an antifreeze molecule cannot just inhibit the growth of ice, it can also trigger its growth," says Koop. The scientists have tested two naturally occurring antifreeze proteins: the protein of the larvae of the mealworm beetle and the protein of an artic fish, the ocean pout. They observed the effect of the proteins on thin microfluidic

In a new study, researchers have confirmed that anti-freeze proteins possess an unusual second property: at low temperatures, they can promote rather than inhibit the growth of ice crystals.

chips, developed at the Weizmann Institute, that are permeated with microscopically small channels with droplet traps. They took pure distilled water and added a set concentration of the specific protein. Then they injected this protein solution into the chip. In the chip, minute drops of water were collected in the droplet traps. Then they placed the chips in a temperature-controlled cooling chamber that cooled them down to minus 40 degrees. "The pure drops in our chip should actually first freeze at minus 38.4 degrees," says Koop. However, the opposite occurred. "When the drops contained the purportedly ice-inhibiting antifreeze proteins, the ice crystal embryos already began to form and grow at warmer temperatures." Hence, in the case of the protein of the larvae of the mealworm beetle, one-half of all the drops already started to freeze at minus 33.9 degrees. "This enabled us to show that whether the antifreeze proteins have ice-inhibiting or ice-promoting properties depends on temperature. There has been speculation over the ambivalence of such proteins for many years, but we are the first to confirm this experimentally," says Professor Dr. Ido Braslavsky from the Hebrew University of Jerusalem. Professor Dr. Yinon Rudich from the Weizmann Institute adds, "It was only having the chip that enabled us to study the formation of ice through antifreeze proteins experimentally." Some of the experiments for the study were carried out at Bielefeld University. Complementary freezing experiments and the chips used to study the water as well as the protein solutions came from the Weizmann Institute of Science in Rehovot.
The antifreeze proteins of the larvae of the mealworm beetle and the artic fish were produced at the Hebrew University of Jerusalem at the Rehovot campus. Ice inhibition of the same protein solutions was also demonstrated there. Ice-inhibiting and ice-promoting proteins are not just common in nature. Nowadays, they are also used as technical aids. For example, antifreeze proteins in varnish can help protect the varnished surfaces from frost. The proteins can also be added to ice cream to help keep it creamy. Ice-forming proteins are used in, for example, ski resorts so that artificial snow can already be produced at a temperature of minus 3 degrees without having to wait for temperatures to drop further.

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Surface wear describes the process of material loss when two surfaces come into contact with each other.

Researchers simulate the process of adhesive wear

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Surface wear describes the process of material loss when two surfaces come into contact with each other. It has significant economic, social and

health consequences—consider the fine particles emitted by moving vehicles. What's more, it can be observed at all levels, from the nanoscale up to the scale of tectonic faults, with the formation of gouge. There are several wear mechanisms, yet the adhesive type is most common. It takes place when two surfaces—such as two pieces of the same metal—rub against one another and adhere. One of the parameters that influence the wear mechanism is surface roughness. A better understanding of how surface roughness changes during the wear process would improve our control over this mechanism. This could lead to significant reductions in energy consumption, greenhouse gas emissions and costs. Researchers at EPFL's Computational Solid Mechanics Laboratory (LSMS) have taken an important step in this direction. They have digitally simulated how surface roughness changes over time, and their results are in line with experimental results. What sets their simulations apart is their duration: using a method developed at EPFL, the LSMS researchers were able to simulate these mechanisms over an extended period of time. In other words, they managed to capture the entire process—from the initial geometry to the final fractal geometry. Their findings were published on 8 March in Nature Communications. This study is the LSMS researchers' third on adhesive wear. Their first study—published in 2016 in Nature Communications - used digital simulations to describe how the process of adhesive wear produced fine particles. In 2017, taking their simulations further, they came out with a second study, appearing this time in Proceedings of the National Academy of Science, demonstrating that it was possible to predict the volume, shape and size of these particles.

Incomplete picture

Scientists are still far from fully understanding the physics underlying wear, and engineers must still carry out ad hoc experiments for each situation. What is known, however, is that worn surfaces display a characteristic fractal morphology, called self-affine, that has some fundamental properties regardless of the material and the scale. The origins of this self-affine morphology are still unknown. Little work has been done on how surface roughness changes over time—and it has been mostly experimental. One limitation of experiments is that, because of the debris that forms, it is not easy to monitor how surface morphology changes during the rubbing process. The researchers overcame this problem through their digital simulations, which provide a constant stream of data.

Powerful digital simulations

Gossip

"We used high-performance computer simulations to track the change in surface morphology in 2-D materials," says Enrico Milanese, a Ph.D. student at the LSMS. "In our simulations, we observed that contact between two surfaces always generates a wear debris particle. That particle is then forced to roll between the two surfaces, wearing them down. This led us to conclude that wear debris must be present for the surfaces to develop their characteristic self-affine roughness." In the future, the LSMS researchers hope to explore the origins of adhesive wear by applying their simulation approach to 3-D models of materials that are of interest to industry.

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Stressing and straining: Geochemists answer fundamental question of mineral reactions

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Argonne researchers used coherent X-ray diffraction imaging to look at the strain inside an iron nanoparticle as it oxidised.

For geoscientists, looking at how minerals react in different conditions can provide a great deal of information about the characteristics of the materials that make up our world. In some cases, merely exposing minerals to water-based environments can yield interesting properties and results. In a new study from the U.S. Department of Energy's (DOE) Argonne National Laboratory, scientists placed small iron oxide particles in an acidic solution, causing the oxidation of iron atoms on the surface of the particles. As the reaction progressed, the researchers observed strain that built up and penetrated inside the mineral particle. "What's really novel about this work is that we're doing it with geological minerals that can have irregular morphologies, as opposed to idealized particles with well-defined shapes. It's a new application of these tools to understand how [oxidation] happens in nano-sized minerals," said Paul Fenter, Argonne physicist. The shape of the particles controlled the degree and type of strain, said Argonne physicist Paul Fenter. "When we look at how things react, we are not typically worrying so much about the shape or morphology of the material. In this case, we have a result in which the spatial distribution of reactivity within the particle is not uniform, which we think is ultimately controlled by its size and shape," he said. In looking at the iron oxide particles, also known as magnetite, Fenter and his colleagues observed the formation of hematite, a reaction that begins at the particle surface. "Essentially, what's happening is that we're changing from one kind of rust into a different kind of rust," said postdoctoral researcher Ke Yuan, the first author of the study. When

the researchers observed the changes in the particle caused by the oxidation, they observed strain that penetrated inside the material, as well as the appearance of isolated defects. "We're moving away from an understanding of these reactions as happening uniformly in one big clump of material toward a more sophisticated understanding of how the particle shape and morphology can alter and influence how a reaction proceeds," Fenter said. "Even though these particles are all magnetite, they all react in somewhat different ways, and so this is a challenge for understanding how reactions proceed in systems where you have different micro- and nanostructures of the particles," Yuan added. To identify the strain distributions in the material, the researchers used a technique called coherent diffraction imaging (CDI), which allowed them to peer into the atomic lattice of the material. Using CDI at Argonne's Advanced Photon Source (APS), a DOE Office of Science User Facility, the scientists were able to detect a small reduction in the lattice spacing—less than one percent—as a result of the oxidation of the iron. This small differentiation in the lattice spacing was spread unevenly throughout the iron oxide particles; the researchers believe it to be responsible for creating the defects that the scientists observed.

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Purdue researchers develop innovative, more cost-effective method to make drugs

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The United States Food and Drug Administration wants the pharmaceutical industry to get away from making drugs using the traditional batch method and switch to a more modern process known as continuous manufacturing.

The United States Food and Drug Administration wants the pharmaceutical industry to get away from making drugs using the traditional batch method and switch to a more modern process known as continuous manufacturing. The FDA put out a statement on 26 February saying the continuous process allows manufacturers to more easily scale operations to meet demand and should help reduce drug shortages. The statement also said continuous manufacturing can provide a more robust, lower cost and diverse supply of drug products. David H. Thompson, a professor in Purdue's Department of Chemistry and a member of the Purdue University Centre for Cancer Research, has written a research paper published in Organic Process Research and Development about how to make a generic form of lomustine, prescribed to people with Hodgkin lymphoma and certain brain cancers. But the continuous manufacturing process described in the paper is not just limited to lomustine. It can be applied to many other products. The ability to reduce production costs

has the potential to allow for more agile and cost-effective production of many life-saving medicines. The goal is to improve manufacturing flexibility, enhance quality and uniformity, while lowering the costs for patients. This is especially important for achieving the anticipated benefits of personalised and regenerative medicine products that target tiny patient populations that currently make their manufacture on large-scale cost-prohibitive. Continuous manufacturing is an alternative to "batch" production where the drug product is produced continuously through a sequence of coupled flow reactors. Thompson and his team selected continuous manufacture for lomustine production because of improved quality monitoring throughout the manufacturing process. In addition, this approach can also reduce production costs by utilising a safer and smaller production facility. Thompson began working on applying his innovative continuous manufacturing process for lomustine after reading an article written by Dr. Henry Friedman, a well-known Duke University neuro-oncologist, in The Cancer Letter in September 2017. The article wrote about how the cost of lomustine had risen dramatically. Thompson approached his team and said they needed to do something. "We have to help the people impacted by this problem. We must show how to make lomustine quickly and cheaply, to provide an alternative for people in need," he said. Within six months, Thompson's team developed a method to make lomustine at a rate equivalent to one dose every two hours using continuous manufacture. His group is now developing methods to scale up the production rate. "All of this is happening in a space that is the size of a small desk. A very small footprint," Thompson said. Thompson said the speed of development was aided by Purdue's Bindley Bioscience Centre at Purdue's Discovery Park because this resource brings together researchers from different disciplines, and makes available key instrumentation. Not satisfied with simply demonstrating a solution, Thompson has joined with credible industry partners and founded Continuity Pharma to translate its process to the scalable production of lomustine. This work aligns with Purdue's Giant Leaps celebration, celebrating the global advancements in health, longevity and quality of life as part of Purdue's 150th anniversary. Health is one of the four themes of the yearlong celebration's Ideas Festival, designed to showcase Purdue as an intellectual centre solving real-world issues. The researchers have filed for a patent on their continuous synthesis process to make lomustine with the help of Purdue's Office of Technology Commercialisation.

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Gossip

Chemical hydrogen storage system

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Hydrogen is a highly attractive, but also highly explosive energy carrier, which requires safe, lightweight and cheap storage as well as transportation systems. Scientists at the Weizmann Institute of Science, Israel, have now developed a chemical storage system based on simple and abundant organic compounds. As reported in the journal Angewandte Chemie, the liquid hydrogen carrier system has a high theoretical capacity and uses the same catalyst for the charging-discharging reaction. Hydrogen carries a lot of energy, which can be converted into electricity or power, and the only by-product from combustion is water. However, as hydrogen is a gas, its energy density by volume is low. Therefore, pure hydrogen is handled mostly in its pressurised state or liquid form, but the steel tanks add weight, and its release and usage are hazardous. Apart from tanks, hydrogen can also be masked and stored in a chemical reaction system. This is in principle the way nature stores and uses hydrogen: In biological cells, finely adjusted chemical compounds bind and release hydrogen to build up the chemical compounds needed by the cells. All these biological processes are catalysed by enzymes. Powerful catalysts mediating hydrogen conversion have also been developed in chemical laboratories. One example is the ruthenium pincer catalyst, a soluble complex of ruthenium with an organic ligand, developed by David Milstein and his colleagues. With the help of this catalyst, they explored the ability of a reaction system of simple organic chemicals to store and release hydrogen. "Finding a suitable hydrogen storage method is an important challenge toward the 'hydrogen economy,'" the authors of the publication explained their motivation. Among the conditions that have to be fulfilled are safe chemicals, easy loading and unloading schemes, and as low a volume as possible. Such a system, consisting of the chemical compounds ethylenediamine and methanol, was identified by Milstein and his colleagues. When the two molecules react, pure hydrogen is released. The other reaction product is a compound called ethylene urea. The theoretical capacity of this "liquid organic hydrogen carrier system" (LOHC) is 6.52 percent by weight, which is a very high value for a LOHC. The scientists first set up the hydrogenation reaction. In this reaction, liquid hydrogen carriers ethylenediamine and methanol were formed from ethylene urea and hydrogen gas with hundred percent conversion when the ruthenium pincer catalyst was used. Then they examined the hydrogen release reaction, which is the reaction of ethylenediamine with methanol. Here, the yield of hydrogen was close to 100 percent, but the reaction seemed

Reversible liquid organic hydrogen carrier system made of simple organic chemicals

to proceed over intermediate stages and ended with an equilibrium of products. Nevertheless, full re-hydrogenation was possible, which led the authors to conclude that they had indeed developed a fully rechargeable system for hydrogen storage. This system was made of liquid organic compounds that are abundant, cheap, easily handled, and not very hazardous. Its advantage is the simple nature of the compounds and the high theoretical capacity. However, to be more efficient and greener, like setup in nature, reaction times must still be shorter and temperatures lower. For this, even "greener" catalysts should be examined.

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Electrifying wound care: Better bandages to destroy bacteria

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A recent study is offering new clues about the science behind bandages infused with electricity, and researchers say the findings could help lead to better wound treatment.

Bandages infused with electricity can help heal wounds faster than typical bandages or antibiotics -- but for years, researchers have not really understood why. A recent study by a team at The Ohio State University is offering new clues about the science behind those bandages, and researchers say the findings could help lead to better wound treatment. The bandages belong to a class of therapies called electroceuticals, which are devices that use electrical impulses to treat medical issues such as wounds. The study, published online recently in the journal Scientific Reports by a research team at The Ohio State University, is the first of its kind to look at the ways electroceutical bandages kill bacteria around a wound, allowing wounds to heal faster. Electroceutical bandages have been used to treat wounds since at least 2013. "The goal is to heal non-healing or chronic wounds, and, if infection is present, to remove infection," said Shaurya Prakash, an associate professor of mechanical and aerospace engineering and co- author of the study. "And what we wanted to understand was the mechanism behind why these electroceutical treatments work to kill bacteria. "Biofilms are small communities of microorganisms -- including bacteria -- that can live on the surface of the skin or a wound. The communities are held together by something called extracellular polymeric substances -- EPS for short. The substances are generally made up of fats and proteins, and can create a protective barrier that keeps bacteria safe from traditional clinical treatment options, including antibiotics. That means that even with traditional antibiotic treatments, some skin infections can linger and prevent wounds from healing. But electroceutical bandages made of the right materials can

break through that barrier, Ohio State's research shows, destroying bacteria and allowing wounds to heal faster. The team developed a new model to study soft-tissue infections to learn more about how the bandages work. The Ohio State study used haboti silk, a common Japanese weave, in the bandages. They silk-screened silver lines onto the silk, and attached a small device to deliver electricity to the biofilm. When they applied the electrified bandage to bacteria-laden biofilm in the lab, the bacteria were destroyed. The research team used electron microscopes to monitor the bacteria. They saw that the electric current disrupted the biofilm enough to begin destroying bacteria. They also saw that bacteria continued to die off two days after the electric current was turned off. Their theory, based on these experiments, is that the bandage and electric current produce a potent antimicrobial chemical -- hypochlorous acid -- that takes over and kills bacteria without harming the healthy skin nearby. This recent study was conducted on bacteria and biofilms in vitro, essentially meaning in a petri dish rather than on a human or an animal. Prakash is quick to point out that the studies set the stage for further research -- experiments that will help scientists better understand the reasons why biofilms work the way they do. That fundamental understanding will help improve the design of electroceutical bandages, he said. But in the meantime, Prakash and his team sent a few prototypes to The Ohio State University College of Veterinary Medicine. Last year, veterinarians used the bandages to help heal an open sore on a dog with a wound that just wouldn't get better, even while being treated with antibiotic medications. "If infection is present, wounds will not heal," Prakash said. "So, we need to find a way to get through the biofilm to the bacteria." The dog arrived at Ohio State late in 2017 with an open, infected wound. Within a week of using the bandage, half of the wound had healed; within 11 days, the infection had cleared. Those results are promising, Prakash said, but early. The team hopes to conduct additional studies and collaborate with microbiologists at Ohio State to further understand the reasons why these bandages successfully destroy bacteria when other treatment options have failed. The research was funded by Ohio State's Centre for Clinical and Translational Science L-Pilot Program, which is funded by a multiyear Clinical and Translational Science Award (CTSA) from the National Institutes of Health. The research has also received support from Ohio State's Infectious Disease Institute.

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Gossip

Engineered microbe may be key to producing plastic from plants

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With a few genetic tweaks, a type of soil bacteria with an appetite for hydrocarbons shows promise as a biological factory for converting a renewable -- but frustratingly untapped -- bounty into a replacement for ubiquitous plastics. Researchers, like those at the University of Wisconsin-Madison-based, Department of Energy-funded Great Lakes Bioenergy Research Centre, hoping to turn woody plants into a replacement for petroleum in the production of fuels and other chemicals have been after the sugars in the fibrous cellulose that makes up much of the plants' cell walls. Much of the work of procuring those sugars involves stripping away lignin, a polymer that fills the gaps between cellulose and other chemical components in those cell walls. That leaves a lot of useful cellulose, but also a lot of lignin -- which has never carried much value. Paper mills have been stripping lignin from wood to make paper for more than a century, and finding so little value in the lignin that it's simply burned in the mills' boilers. "They say you can make anything from lignin except money," says Miguel Perez, a UW-Madison graduate student in civil and environmental engineering. But they may not know Novosphingobium aromaticivorans as well as he does. Perez, civil and environmental engineering professor Daniel Noguera and colleagues at GLBRC and the Wisconsin Energy Institute have published in the journal Green Chemistry a strategy for employing N. aromaticivorans to turn lignin into a more valuable commodity. "Lignin is the most abundant source -- other than petroleum -- of aromatic compounds on the planet," Noguera says, like those used to manufacture chemicals and plastics from petroleum. But the large and complex lignin molecule is notoriously hard to efficiently break into useful constituent pieces. Enter the bacterium, which was first isolated while thriving in soil rich in aromatic compounds after contamination by petroleum products. Where other microbes pick and choose, N. aromaticivorans is a biological funnel for the aromatics in lignin. It is unique in that it can digest nearly all of the different pieces of lignin into smaller aromatic hydrocarbons. "Other microbes tried before may be able to digest a few types of aromatics found in lignin," Perez says. "When we met this microbe, it was already good at degrading a wide range of compounds. That makes this microbe very promising." In the course of its digestion process, the microbe turns those aromatic compounds into 2-pyrone-4,6-dicarboxylic acid -- more manageably known as PDC. By removing three genes from their microbe, the researchers turned the intermediate PDC into the end of the line. These engineered bacteria

With a few genetic tweaks, a type of soil bacteria with an appetite for hydrocarbons shows promise as a biological factory for converting a renewable -- but frustratingly untapped -- bounty into a replacement for ubiquitous plastics.

became a funnel into which the different lignin pieces go, and out of which PDC flows. Bioengineers in Japan have used PDC to make a variety of materials that would be useful for consumer products. "They have found out the compound performs the same or better than the most common petroleum-based additive to PET polymers -- like plastic bottles and synthetic fibres -- which are the most common polymers being produced in the world," Perez says. It would be an attractive plastic alternative -- one that would break down naturally in the environment, and wouldn't leach hormone-mimicking compounds into water -- if only PDC were easier to come by. "There's no industrial process for doing that, because PDC is so difficult to make by existing routes," says Noguera. "But if we're making biofuels from cellulose and producing lignin -- something we used to just burn -- and we can efficiently turn the lignin into PDC, that potentially changes the market for industrial use of this compound." For now, the engineered variation on N. aromaticivorans can turn at least 59 percent of lignin's potentially useful compounds into PDC. But the new study suggests greater potential, and Perez has targets for further manipulation of the microbe. "If we can make this pipeline produce at a sufficient rate, with a sufficient yield, we might create a new industry," Noguera says. The Wisconsin Alumni Research Foundation has filed a patent application on this technology. This research was funded by grants from the Department of Energy (BER DE-FC02-07ER64494 and DE-SC0018409) and the Chilean National Commission for Scientific and Technological Research.

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Researchers are developing chemical analyses and advanced DNA techniques to get more evidence out of fingerprints

Fingerprints are more than just patterns; they're chemical identities

2019-03-12

On 24 March 1994, a man walking his dog in Albany, Georgia, found the body of a woman named Angela Sizemore, who had been brutally raped and murdered and left in the front seat of her SUV behind an apartment complex. When they arrived at the scene, crime-scene technicians collected semen from the body and fingerprints from the vehicle in an attempt to identify the killer. At the time, DNA analysis was accurate enough to pinpoint a suspect on the basis of the genetic code within sperm cells, and fingerprint analysis could ID a suspect from the loop-and-whorl patterns left behind by substances on the skin. The semen analysis identified Georgia resident Marcus Ray Johnson as having had sex with Sizemore sometime before her death. Witnesses also placed someone

fitting Johnson's description near the site where police believed Sizemore was murdered the previous night. Investigators collected a total of 38 fingerprints from the victim's vehicle; all but one was too smudged to use properly. The one print that was clear went to AFIS, the digital fingerprint database commonly used by law enforcement, but it wasn't a match for any prints logged there. Johnson claimed that he'd had consensual sex with Sizemore on the night of the murder after meeting her in a bar and had left her alive. He was convicted of murder and sentenced to death row, where he continued to assert his innocence. Today, scientists are working to get more from fingerprints than just loops and whorls, developing methods to analyse molecules such as DNA, amino acids, or explosives in fingerprint residues. Years after his conviction, Johnson's lawyers hoped new techniques, applied to the prints collected in 1994, might uncover information that would exonerate their client. With these methods, scientists can now work with samples containing as little as 500 nL of material, making the chemical analysis of fingerprints more feasible. For instance, a fingerprint contains much less DNA than the cheek swabs for which most forensic processes have been optimized. It's only in the past decade that chemical analysis techniques have become sensitive enough to glean a biological profile from such a small sample, says Tracey Dawson Cruz, a forensic molecular biologist at Virginia Commonwealth University. The idea is not necessarily to do away with pattern comparison during fingerprint analysis—and, indeed, other scientists are focusing on ways to improve the clarity of the pattern itself—but instead to bolster the analysis with more information. Smudged prints needn't be a completely lost cause. In some older cases, DNA from archived fingerprints may be "the only chance" for biological evidence, Dawson Cruz says. She is among those working to extract more from fingerprints, tapping into the potential treasure trove of chemical information hidden within. As Johnson neared the end of his permitted appeal period nearly 20 years after the murder, his lawyers, seeking a final opportunity to uncover exculpatory physical evidence, asked the court to allow DNA analysis of the fingerprints collected in 1994. Georgia's state forensic laboratory had never done such an analysis, but Johnson's lawyers came to court armed with results from VCU scientists, including Dawson Cruz. These researchers had been exploring the possibility of retrieving usable DNA profiles from fingerprints collected decades earlier. Fingerprinting research usually focuses on latent fingerprints. These patterned deposits of sweat, skin cells, and other substances are often smudged, small, or incomplete when collected from a crime scene, as opposed to the pristine sets of prints typically collected with an ink pad in a controlled setting. Latent prints are one of the oldest forms of forensic evidence—having connected criminal

to crime scene for more than a century—and are based on the assumption that everyone has a unique set of patterns on their fingertips.

Today, latent fingerprint collection is "a staple of every crime scene" where there are surfaces from which prints can be lifted, says Carl Speckels, a forensic scientist at the Phoenix Police Department's forensic laboratory. Forensic technicians typically visualise the prints by dusting them with powder and lifting them with adhesive tape, using a dye stain, or fuming the area with cyanoacrylate (vaporized superglue). The prints are then photographed or scanned. At that point, an examiner must decide whether a collected print is good enough to attempt an individualization. This means comparing the latent fingerprint with a fingerprint from a known subject and determining if there is enough information in the ridges and whorls to suggest both samples were left by the same person. Forensic scientists use the term individualization instead of the word match because the analysis is about probability, not necessarily certainty. In Phoenix, Speckels says, about 30–40% of latent prints are determined to be high enough quality to send through AFIS. Some of the remaining prints are compared manually by a human fingerprint analyst, and the rest—smudged or otherwise corrupted—are simply stored as evidence, often pressed between the adhesive tape used to lift them and a paper backing card. For decades, fingerprint individualization was the only reason for lifting latent prints from a crime scene. Marilyn Miller, a VCU forensic scientist whom Johnson's lawyers asked for assistance reopening his case, saw potential in the 37 smudged and low-quality latent prints stored away. She brought the project to Dawson Cruz with the hope that she would be able to find a way to extract usable DNA from the archived samples—samples that had been sealed away simply to preserve their ridge patterns, with no consideration given to conserving genetic information. Dawson Cruz found that the type of black powder used to dust for prints in 1994 did not significantly interfere with her ability to extract DNA from them; neither did cyanoacrylate fuming. In fact, the DNA, housed in skin cells, was protected and preserved in its tape-and-card sandwich. The challenge was to remove the DNA from the substrate while minimising damage and loss of genetic material and while isolating and concentrating as much of the sample as possible. Dawson Cruz and colleagues examined every part of the DNA-extraction process with an eye toward optimizing protocols and getting as much usable genetic information from archived fingerprints as possible (J. Forensic Sci. 2017, DOI: 10.1111/1556-4029.13504). Working with fingerprint samples ranging in age from 0 to 28 years old, the VCU team found they could extract the most skin cells, and thus DNA, by pulling apart the fingerprint sandwich

of tape and paper, cutting each layer into strips, and then immersing the strips in a solution designed to break open cell membranes and release the DNA. These discoveries, as well as other recommendations, could have broader implications for improving the analysis of DNA from fingerprints in present-day investigations, Dawson Cruz says. That area of research is young—beginning in the late 1990s—and forensic scientists are still working out the kinks. In fact, DNA recovery from a simple swab of a touched surface has a 60–80% failure rate, she notes, and that's without the additional complications presented by archived latent prints. As Dawson Cruz is looking to extract genetic information from aged prints, other researchers are looking to make better use of those smudges by examining other chemicals contained within. Jan Halámek and colleagues at the University at Albany are interested in the amino acids found in fingerprint sweat. The profile of these residues is controlled by metabolic processes in the body that fluctuate depending on a person's biological sex, age, and other factors.

NIST research chemist Jessica Staymates developed this adhesive swab that can withstand the high heat of analytical instruments while retaining a fingerprint pattern for later analysis. Halámek's team developed a collection of chemical and enzymatic assays that can assess a handful of the 23 amino acids present in human sweat, producing a colour change, with intensity corresponding to the level of metabolite present in a sample. The group first used these analyses to distinguish between samples from female and male sources; amino acid levels are known to be roughly twice as high in the sweat of females as in males. More recently, the researchers published work showing they could use the levels of metabolites in sweat to distinguish between samples from two different people, regardless of sex (Anal. Chem. 2018, DOI: 10.1021/acs.analchem.8b00414). "We don't compete with DNA," Halámek says. The advantage of the assays, he says, is that they can analyse samples at the crime scene more rapidly and cheaply than DNA testing. So, they could be used to determine quickly whether a particular print is from a man or woman or identify whether multiple people were present at a crime scene. The shortcoming, though, is that, unlike DNA, metabolite levels fluctuate according to age, activity level, and other factors, so the assays would be unable to pinpoint the identity of a suspect. Halámek proposes using such a technique to pre-sort samples found at a crime scene, reducing redundant DNA analysis and ensuring the samples are actually human sweat—and not, for example, a dog's drool—before performing expensive and time-consuming laboratory tests. "If you have a red liquid, you want to be sure it is blood, not ketchup. And same with the sweat," he says. The

assays can be run with less than a droplet of sweat, leaving the rest of the sample for later lab tests. Other forensic scientists want to extract not the chemicals produced by a person's body but rather the chemicals they might have touched before leaving a fingerprint—explosives, for instance. When investigating a suspicious package, responders' first objective is to determine whether the package may be dangerous, but they may also need to track down the person who abandoned it. The chemicals in fingerprints left on the outside of the package can offer clues. But the portable ion mobility spectrometry instruments that agents typically use to screen for explosives employ high temperatures to vaporize the chemicals in question and would destroy traditional fingerprint-lifting materials, like adhesive tape. So, if the package did turn out to be a bomb and agents had already screened the print for explosives via standard methods, its pattern would be too damaged to help track down who left it there. "That piece of tape could never go into one of these trace detectors, because it would melt, and it would have so many chemicals that come off and get in the way of the chemical analysis," says Jessica Staymates, a research chemist at the National Institute of Standards and Technology. Staymates and colleagues wanted to develop a method that would analyse a fingerprint for chemical residues while preserving its pattern. "The idea for this was a quick chemical analysis that you could do at the scene of a crime or the scene of a potential bomb. You'd quickly lift the fingerprint and analyse it for the chemistry part first" and then use the pattern for comparison after, Staymates says. To do that, the researchers would need temperature-resistant swab materials that were smooth, to preserve a print's ridge pattern, and light coloured, to enable visualisation of the dark fingerprint powder. After testing several combinations, they settled on a white Teflon strip paired with a high-temperature adhesive originally created for aerospace use. They proved that it worked by creating prints with artificial fingers moulded from ballistic gelatin that had been pressed into simulated plastic explosives (Int. J. Ion Mobility Spectrom. 2014, DOI: 10.1007/s12127-014-0148-6). Importantly, the print pattern stayed intact and could still be used for identification. "That's the holy grail right there for this whole project," Staymates says. NIST is currently in the process of patenting the swab and adhesive.

As the team working on Johnson's fingerprint evidence found, just because these techniques for chemically analysing fingerprints have been shown to work in the lab, the road to validate the methods and ensure that results are admissible in court is a long one. At the time Johnson's lawyers petitioned to have the two-decades-old fingerprints from his case analysed for DNA, the VCU group had just begun tests to see whether

they could obtain usable DNA from old prints. They'd presented promising results at a scientific meeting but hadn't yet published them. And no other scientists had replicated their findings. "We were just starting to get some results," says VCU's Miller, who was asked to testify at one of Johnson's last hearings, in 2014. "I couldn't cite the fact that anything had been peer reviewed; nothing had been published because it just hadn't happened yet. Research takes time, and Marcus Ray Johnson was running out of time." Miller testified that the team had been able to extract usable DNA from archived fingerprints as much as 20 years old. But Amy Vosburg-Casey, one of Johnson's lawyers at the time, remembers the judge describing the science as "not settled enough." The court did not grant the lawyers' request, and the archived prints from Johnson's case were not analysed for DNA. Johnson was executed on 19 November 2015. The latent prints and other evidence from Johnson's case have since been destroyed. "It's awful; I think about it all the time," Vosburg-Casey says, adding that she still feels frustrated that although Johnson's lawyers collected multiple witness accounts suggesting Johnson had left Sizemore alive, they were unable to uncover physical evidence—such as DNA from fingerprints collected at the crime scene—to exclude Johnson or implicate a different attacker. There has long been a need in the forensic science community to research new ways to analyse crime-scene evidence, especially since 2009, when the National Academy of Sciences published a report asserting that many forensic disciplines—fingerprint analysis included—have little or no scientific underpinning. The report drew a sceptical eye to a field in which validity had long been assumed rather than proved. But VCU's Miller thinks the forensic community has made strides in the 10 years since that report to build a body of new, rigorous research to strengthen the value of forensic science. One major advance was the 2014 creation of the Organisation of Scientific Area Committees, formed through an agreement between the US Department of Justice and NIST. The organisation includes discipline-specific committees whose goal is to establish scientific standards that act to not only foster reliable results from existing forensic analysis techniques but also help vet new ones. These efforts will help ensure forensic techniques are ready to stand up to the scrutiny of the courts and provide the best information possible. It has been a slow process, says Richard Cavanagh, who oversees NIST's forensic science initiatives. The first standards—including guides for fire investigation and drug identification—have been approved in the past few years. Many others, including ones for fingerprint analysis, are still in the works. And researchers like Dawson Cruz, Miller, Halámek, and Staymates are dedicated to the effort, working to provide the empirical

studies that, together with objective standards, are needed to expand and strengthen the nation's use of forensic science.

Chemical & Engineering News, 10 March 2019

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

The fight over the longest carbon-carbon bond is redefining what a bond is

2019-03-12

What is a carbon-carbon bond? You might think this is a question with a simple answer, but chemists are still working to figure it out. To do so, they are pushing carbon-carbon bonds to their very limits. Amid claims about who holds the record for longest bond, a more detailed story of bonding is emerging. At Justus Liebig University Giessen, in Germany, Peter R. Schreiner admits that his research group has become a bit obsessed with bonding. The fascination took hold when the scientists stumbled upon a surprisingly long but stable carbon-carbon single bond. Their original aim, Schreiner says, was to synthesise artificial diamonds by stitching together carbon cages called diamondoids and "heating the hell out of them." But in the process, they discovered the oddball bond, he says, and they became obsessed. "I remember that very day in 2010 when my co-worker came back with the X-ray structure of the product," Schreiner says. The doctoral researcher in Schreiner's lab had made a molecule with two diamantane cages linked by a carbon-carbon bond. The bond was much longer than normal. Not only was the resulting bond long, but it was also surprisingly stable. The molecule didn't dissociate until it was heated above 200 °C. Long bonds are usually weak bonds, so Schreiner predicted that the long carbon-carbon bond would break apart at a much lower temperature. "The first thing I thought was that something was wrong," Schreiner recalls. "So, I asked him to make even bigger and bigger ones—superlong bonds." And that's how the competition over ultralong bonds began. Typical carbon-carbon bonds in alkanes measure 1.54 Å. Since 2011, one of Schreiner's diamondoid compounds held the record for containing the longest single carbon-carbon bond (Nature 2011, DOI: 10.1038/nature10367). Its bond had a length of 1.704 Å. But once something is declared a record, people will certainly look to beat it. Two papers published in 2018 challenged Schreiner's record and stretched the very idea of a carbon-carbon bond even further. But even though the new bonds are longer, they're situated in very different molecules and thus in very different bonding environments. In some respects, the competing molecules are not comparable at all. Building on Schreiner's

What is a carbon-carbon bond? You might think this is a question with a simple answer, but chemists are still working to figure it out.

compound to make carbon-carbon bonds even longer would have been difficult because of a unique characteristic it has, says Takanori Suzuki of Hokkaido University. He explains that Schreiner's carbon-carbon bond is a simple single bond, the kind found in alkane molecules such as ethane. But if the bond breaks between the cages in the compound, the molecule dissociates into two separate units, which adds entropy to the system. To stretch such a bond farther, Suzuki says, would mean balancing the dissociation energy of the long bond with the increase in entropy caused by breaking that bond. So, when Suzuki and his group set out to break Schreiner's record, they wanted to make sure they reduced the entropy gain upon bond dissociation to increase their bond's stability. Suzuki's co-worker Yusuke Ishigaki had the idea to stretch a carbon-carbon bond within a larger molecule so that if the bond breaks, the molecule doesn't split into two. After some work, Ishigaki created a dihydropyracylene compound that broke the record. In a paper published last year, the team reported a bond length of 1.798 Å at –73 °C that expands to 1.806 Å at 123 °C (Chem2018,DOI: 10.1016/j.chempr.2018.01.011). In Suzuki and Ishigaki's molecule, the chemically inert aromatic rings that surround the long carbon-carbon bond act like a shell that stabilizes the bond as it stretches farther and farther. Just a few months after this team reported its feat, a group based in China announced it had made an even longer carbon-carbon bond (Angew. Chem., Int. Ed. 2018, DOI: 10.1002/anie.201812555). During the synthesis and functionalization of 1,2-diamino-o-carboranes, Xu-Qiong Xiao's group at Hangzhou Normal University found exceptionally long carbon-carbon bonds. "This was an unexpected finding," Xiao says. "We became curious about it and started to investigate it in detail." The bond lengths they reported topped out at 1.931 Å.

Although these record-breaking lengths are impressive, not everyone thinks the focus on one-upmanship among the groups is helpful. "One really doesn't want to get into the phenomenon of boys comparing the length of their sexual equipment," says Nobel laureate Roald Hoffmann of Cornell University. "You can quote me on that." "The strategies for elongating carbon-carbon bonds," Hoffmann contends, "are more important for chemistry than the records." In fact, everyone C&EN spoke to for this story was clear that while all three groups had created long bonds between carbon nuclei, the bonding environments of the three molecules are different from one another. What is important about all three groups' work, experts say, is how these long bonds were made and what they teach us about bonding itself. Chemists know that covalent bonds are based on electrons shared between nuclei. Atomic nuclei stick together to form molecules because the nuclei are attracted to the negatively

charged electrons on other atoms more strongly than they are repelled by the nuclei in those atoms. How the electrons are arranged around the nuclei, and how bonds are made and broken, is ultimately what controls chemistry. Lines and arrows drawn on a page to show electron movement between atoms often describe what is happening in reaction flasks pretty well. But bonds aren't quite as simple as these diagrams suggest. It is easy to visualize a carbon-carbon bond by drawing a line between two carbon atoms, says Anastassia Alexandrova, a specialist in electronic structure and chemical bonding at the University of California, Los Angeles. But, she says, the reality of bonding can become more complicated the more you study it. "Every model [of bonding] is wrong," she adds. "But some are useful, and that's all that matters." A close look at Schreiner's molecule reveals that it is stabilized by attractive dispersion forces known as London forces. These weak bonds exist between the hydrogen atoms on the cages on either side of the molecule, like two panes of glass that can stick together when touching face to face. Although individual dispersion interactions are weak, the effect is significant because there are so many hydrogen nuclei that can interact. In the middle of the molecule, the ultralong carbon-carbon bond is essentially an alkane bond like the other carbon-carbon bonds within the cages of the molecule. That is not true of the unique carbon-carbon bonds that Suzuki's and Xiao's teams made, and that is why Schreiner still claims to hold the record for the longest alkane bond. Ishigaki and Suzuki's bond, for example, exists within a neutral hydrocarbon, just like Schreiner's, but it is surrounded by aromatic rings and is not a straightforward alkane bond, as the researchers discovered in their study. In addition to using X-ray crystallography to determine the molecule's structure, the team examined the bond's character with Raman spectroscopy. That sort of analysis is something Hoffmann wishes more groups would do. Instead of characterising their unusually long carbon-carbon link as a pure alkane bond, the Japanese researchers describe it as "fuzzy." It is, they say, a weak bond that is a mix of different quantum states. The team's unusual carbon-carbon bond might be weak, but it is still officially a bond and still longer than 1.803 Å, the shortest nonbonding distance between carbon nuclei calculated for caged dimer molecules. This theoretical limit is the length at which the bond dissociation energy is predicted to be zero. What Ishigaki has shown in this molecule—which can't break apart if the carbon-carbon bond is severed—Suzuki says, is that "the bonded state and nonbonded state are connected seamlessly, in terms of the interatomic carbon-carbon distance." Meanwhile, carboranes and related molecules, like those studied by Xiao's group, were already known to have inherently long, weak bonds. In fact, Hoffmann says he first measured carborane bond lengths himself when he was a grad student.

The bonds in carboranes are typically long because the electrons within the cluster are often shared between more than two nuclei. The carbon-carbon bond in the Xiao group's molecule is still a covalent bond, but its character is, again, not that of a simple alkane bond, because of the nitrogen and boron atoms also present in the molecule. Xiao explains that the length of the remarkable carbon-carbon bond in his group's cluster can be attributed to a delocalized nitrogen lone pair adding to the antibonding orbital of the special carbon-carbon bond. Xiao refers to this effect as negative hyperconjugation, whereas Hoffmann says he would use the term orbital interaction. Regardless of the name, "the analysis is pretty good," Hoffmann says, "and I think it's interesting that these bonds come out as long as they are." Suzuki agrees, adding that what matters is "not how long the bond is but how it was realised and how many new findings there are." And that underscores the important point about this work. UCLA's Alexandrova is one of the organisers of an annual conference on chemical bonding, which brings together researchers to explore the nature of the chemical bond. The forum still exists, she explains, because this discussion continues. These three groups are working on distinct aspects of bonding and studying very different types of chemical systems. But they are all focusing on carbon-carbon bonds to understand bonding better. At the same time, they hope that what they learn will one day be useful. Schreiner, for example, describes his primary motivation for continuing to pull at carbon bonds as simple curiosity. But he hopes to apply what he learns to his work on catalysis and transition states. Other researchers suggest that understanding these extreme bonding situations could help design novel functional materials or new chelating ligands. But while there is hope that these bonding insights might find practical use, Hoffmann says he would make a case for continuing the work purely from an intellectual standpoint. "I think testing the limits gives you a better understanding of the concept," he says, adding that these researchers are "enriching our understanding of the carbon-carbon bond." To understand the nature of covalent bonds, chemists have to understand extreme cases. And one of those extremes is length. In Hoffmann's view, extreme cases can teach us about molecules with typical bond lengths. They can also be used like paradoxes, to help us interrogate basic chemistry assumptions, he adds. "I think it's nice that we're stretching or breaking some general chemistry rules," Alexandrova says. "It's something that I could even use in my class." Xiao agrees: "The carbon-carbon bond is a well-accepted concept that we teach every undergraduate student in freshman courses," he says. But the exact definition remains elusive. These extremes may nudge chemists toward a clearer understanding of molecular structure,

Gossip

but chemical bonding is not a black-and-white concept. Rather, as Schreiner puts it, "it's all a grey zone."

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Curiosities

Radioactive cancer drugs could pose risk to cremation workers

2019-03-13

Cancer patients often receive radioactive drugs that target tumour cells. A new case report suggests there could be unanticipated fallout if these patients die and their bodies are cremated. After learning that one of their patients had died and been sent off for cremation, Arizona doctors sought to discover whether his radioactive medications might have gotten into the air after being superheated, according to their report in JAMA. "What we were really worried about was the possibility of someone breathing in the radioisotope," said the report's lead author, Dr. Nathan Yu, a resident physician in the department of radiation oncology at the Mayo Clinic in Phoenix. "Once you breathe it in, it's in your body and in direct contact with tissues. Our goal in writing this article was to bring this topic to light. Right now, there are no federal regulations regarding cremation of exposed patients." The patient, who was 69 when he died, had been treated with a radiopharmaceutical called Lu 177 dotatate at the Mayo Clinic. The next day he was admitted to a different hospital for very low blood pressure. "He died from his tumour two days later," Yu said. "At the time we were unaware of the unexpected death of the patient. He was cremated and it wasn't till five days after the treatment that we were notified that he had been cremated." Yu and his colleagues were concerned that the heat from the cremation might have volatilised the radioactive drug, sending it into the air where it could be breathed in by anyone working at the crematorium. They contacted Arizona's Board of Radiation Control, which sent out a team to measure any radioactivity in the crematorium that might be traced back to the patient. The bureau's team found contamination in numerous spots, including the oven, the vacuum filter and bone crusher and ascertained that the primary source was the Lu 177. When the Mayo researchers checked the crematory operator's urine, there was no sign of Lu 177, but it did contain another radioactive isotope, Tc 99m, which is used as a tracer in numerous types of diagnostic imaging. "It's possible that he was exposed while cremating another person's remains," Yu said. While the amount of radiation the crematory operator was exposed to was small, co-author Kevin Nelson worries about cumulative exposure. "I think it's pretty small for any individual cremated patient," said Nelson, medical health physicist and radiation safety officer at the Mayo Clinic. "If you're the only operator and you're repeatedly exposed over a lifetime, the risk is additive." The case report was "very informative," said Dr. Amar Kishan, an assistant professor in the department of radiation oncology at the University of California,

Cancer patients often receive radioactive drugs that target tumour cells. A new case report suggests there could be unanticipated fallout if these patients die and their bodies are cremated.

Los Angeles. "As we begin to use radiopharmaceuticals more and more frequently, it will become more and more imperative to ensure that public health considerations are fully evaluated," Kishan, who was not involved in the new report, said in an email. "It is surprising and noteworthy in this case that it was an unexpected isotope often used in diagnostic scans that was the true contaminant. Policies are critical here."

Reuters Health, 1 March 2019

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

For Alzheimer's Sufferers, Brain Inflammation Ignites a Neuron-Killing "Forest Fire"

2019-03-13

For decades researchers have focused their attacks against Alzheimer's on two proteins, amyloid beta and tau. Their build-up in the brain often serves as a defining indicator of the disease. Get rid of the amyloid and tau, and patients should do better, the thinking goes. But drug trial after drug trial has failed to improve patients' memory, agitation and anxiety. One trial of a drug that removes amyloid even seemed to make some patients worse. The failures suggest researchers were missing something. A series of observations and recently published research findings have hinted at a somewhat different path for progression of Alzheimer's, offering new ways to attack a disease that robs memories and devastates the lives of 5.7 million Americans and their families. One clue hinting at the need to look further afield was a close inspection of the 1918 worldwide flu pandemic, which left survivors with a higher chance of later developing Alzheimer's or Parkinson's. A second inkling came from the discovery that the amyloid of Alzheimer's and the alpha-synuclein protein that characterises Parkinson's are antimicrobials, which help the immune system fight off invaders. The third piece of evidence was the finding in recent years, as more genes involved in Alzheimer's have been identified, that traces nearly all of them to the immune system. Finally, neuroscientists have paid attention to cells that had been seen as ancillary- "helper" or "nursemaid" cells. They have come to recognise these brain cells, called microglia and astrocytes, play a central role in brain function—and one intimately related to the immune system. All of these hints are pointing toward the conclusion that both Alzheimer's and Parkinson's may be the results of neuroinflammation—in which the brain's immune system has gotten out of whack. "The accumulating evidence that inflammation is a driver of this disease is enormous," says Paul Morgan, a professor of immunology and a member of the Systems Immunity Research Institute

Alzheimer's and Parkinson's may be the results of neuroinflammation—in which the brain's immune system has gotten out of whack.

at Cardiff University in Wales. "It makes very good biological sense." The exact process remains unclear. In some cases, the spark that starts the disease process might be some kind of insult—perhaps a passing virus, gut microbe or long-dormant infection. Or maybe in some people, simply getting older—adding some pounds or suffering too much stress could trigger inflammation that starts a cascade of harmful events. This theory also would explain one of the biggest mysteries about Alzheimer's: why some people can have brains clogged with amyloid plaques and tau tangles and still think and behave perfectly normally. "What made those people resilient was lack of neuroinflammation," says Rudolph Tanzi, a professor of neurology at Harvard Medical School and one of the leaders behind this new view of Alzheimer's. Their immune systems kept functioning normally, so although the spark was lit, the forest fire never took off, he says. In Tanzi's fire analogy, the infection or insult sparks the amyloid match, triggering a brush fire. As amyloid and tau accumulate, they start interfering with the brain's activities and killing neurons, leading to a raging inflammatory state that impairs memory and other cognitive capacities. The implication, he says, is that it is not enough to just treat the amyloid plaques, as most previous drug trials have done. "If you try to just treat plaques in those people, it's like trying to put out forest fire by blowing out a match."

Lighting the fire

One study published earlier this year found gum disease might be the match that triggers this neuroinflammatory conflagration—but Tanzi is not yet convinced. The study was too small to be conclusive, he says. Plus, he has tried to find a link himself and found nothing. Other research has suggested the herpes virus could start this downward spiral, and he is currently investigating whether air pollution might as well. He used to think amyloid took years to develop, but he co-authored a companion paper to the herpes one last year, showing amyloid plaques can literally appear overnight. It is not clear whether the microbes—say for herpes or gum disease—enter the brain or whether inflammation elsewhere in the body triggers the pathology, says Jessica Teeling, a professor of experimental neuroimmunology at the University of Southampton in England. If microbes can have an impact without entering the brain or spinal cord—staying in what's called the peripheral nervous system—it may be possible to treat Alzheimer's without having to cross the blood–brain barrier, Teeling says. Genetics clearly play a role in Alzheimer's, too. Rare cases of Alzheimer's occurring at a relatively young age result from inheriting a single dominant gene. Another variant of a gene that

transports fats in brain cells, APOE4, increases risk for more typical, later-onset disease. Over the last five years or so large studies of tens of thousands of people have looked across the human genome for other genetic risk factors. About 30 genes have jumped out, according to Alison Goate, a professor of neurogenetics and director of the Loeb Centre for Alzheimer's Disease at Icahn School of Medicine at Mount Sinai in New York City. Goate, who has been involved in some of those studies, says those genes are all involved in how the body responds to tissue debris—clearing out the gunk left behind after infections, cell death and similar insults. So, perhaps people with high genetic risk cannot cope as well with the debris that builds up in the brain after an infection or other insult, leading to a quicker spiral into Alzheimer's. "Whatever the trigger is, the tissue-level response to that trigger is genetically regulated and seems to be at the heart of genetic risk for Alzheimer's disease," she says. When microglia—immune cells in the brain—are activated in response to tissue damage, these genes and APOE get activated. "How microglia respond to this tissue damage—that is at the heart of the genetic regulation of risk for Alzheimer's," she says. But APOE4 and other genes are part of the genome for life, so why do Alzheimer's and Parkinson's mainly strike older people? says Joel Dudley, a professor of genetics and genomics, also at Mount Sinai. He thinks the answer is likely to be inflammation, not from a single cause for everyone but from different immune triggers in different individuals. Newer technologies that allow researchers to examine a person's aggregate immune activity should help provide some of those answers, he says. Cardiff's Morgan is developing a panel of inflammatory markers found in the blood to predict the onset of Alzheimer's before much damage is done in the brain, a possible diagnostic that could point to the need for anti-inflammatory therapy

A similar inflammatory process is probably also at play in Parkinson's disease, says Ole Isacson, a professor of Neurology at Harvard Medical School. Isacson points to another early clue about the role of inflammation in Parkinson's: people who regularly took anti-inflammatory drugs like ibuprofen developed the disease one to two years later than average. Whereas other researchers focused exclusively on genetics, Isacson found the evidence suggested the environment had a substantial impact on who got Parkinson's. In 2008–09, Isacson worked with a postdoctoral student on an experiment trying to figure out which comes first in the disease process: inflammation or the death of dopamine-producing neurons, which make the brain chemical involved in transmitting signals among nerve cells. The student first triggered inflammation in the brains of some rodents with molecules from gram-negative bacteria and then

damaged the neurons that produce dopamine. In another group of rodents, he damaged the neurons first and then introduced inflammation. When inflammation came first, the cells died en masse, just as they do in Parkinson's disease. Blocking inflammation prevented their demise, they reported in The Journal of Neuroscience. Other neurodegenerative diseases also have immune connections. In multiple sclerosis, which usually strikes young people, the body's immune system attacks the insulation around nerve cells, slowing the transmission of signals in the body and brain. The spinal fluid of people with MS include antibodies and high levels of white blood cells, indicating the immune system is revved up—although it is not clear whether that immune system activation is the cause or result of MS, says Mitchell Wallin, who directs the Veterans Affairs Multiple Sclerosis Centres of Excellence. People with antibodies to the Epstein–Barr virus in their systems, especially if they caught the virus in late adolescence or early adulthood run a higher risk of developing MS—supporting the idea that an infection plays a role in MS. Thanks to newer medications and improvements in fighting infections, people with MS are now living longer. This increased longevity puts them at risk for neurological diseases of aging, including Alzheimer's and Parkinson's, Wallin says. Lack of data has left it unclear whether people with MS are at the same, higher or lower risk for these diseases than the general population. "How common it is, we're just starting to explore right now," Wallin says.

Coming soon?

It will be years before the concept of a neuroinflammatory can be fully tested, but there are already some relevant drugs in development. One start-up, California-based INmune Bio, recently received a $1-million grant from the Alzheimer's Association to advance XPro1595, a drug that targets neuroinflammation. The company is beginning its first clinical trial this spring, treating 18 patients with mild to moderate-stage Alzheimer's who also show signs of inflammation. The company plans to test blood, breath by-products and cerebral spinal fluid as well as conduct brain scans to look for changes in inflammatory markers. That first trial will just explore if XPro1595 can safely bring down inflammation and change behaviours such as depression and sleep disorders. Company CEO and co-founder Raymond Tesi, says he expects to see those indicators improve, even in a short, three-month trial. The best way to avoid Alzheimer's is to prevent it from ever starting, which might require keeping brain inflammation to a minimum, particularly in later life. Preventative measures are already well known: eat healthy foods, sleep well, exercise regularly, minimise stress

and avoid smoking and heavy drinking. You can't do anything about your genetics but living a healthy lifestyle will help control your inheritance, says Tanzi, who, along with Deepak Chopra, wrote a book on the topic, The Healing Self: A Revolutionary New Plan to Supercharge Your Immunity and Stay Well for Life. "It's important to get that set point as high as possible."

Scientific American, 4 March 2019

http://www.sciam.com

Toxic fumes from ships linked to thousands of UK deaths

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Pollution from ships has been linked with heart disease, respiratory problems The UK is one of the most vulnerable nations to the toxic fumes spewed out by ships, according to a new study. Analysis by transport experts reveals more than 3,000 British deaths each year can be attributed to shipping emissions. Pollution from boats is linked to early deaths as the toxic gases and particles in fumes trigger health problems including asthma, heart disease and cancer. Despite efforts to clean up the sector, ships still rely on the filthiest fuels for power, resulting in huge volumes of emissions being pumped into the air around port cities. Using data from 2015, the International Council on Clean Transportation (ICCT) team showed Britain ranked fourth for the total number of people dying prematurely due to shipping fumes, just behind China, Japan and India. The UK also comes fourth when judged on deaths per 100,000 people, this time ranking alongside other coastal nations such as Singapore and the Netherlands. "Globally shipping was responsible for about 16 per cent of premature deaths due to [emissions from] transportation – but the UK was in the order of 40 per cent," said Dr Daniel Rutherford, a marine transport expert at the ICCT. Britain's unfortunate position near the top of the charts is largely the result of its proximity to busy shipping lanes to Europe, but also the uneven laws governing pollution on the high seas. "Critically, only one half of British shore is protected by an emission control area," said Dr Rutherford. Ships in the North and Baltic seas must slash sulphur levels in their fuel from 2.5 to 0.1 per cent, meaning they produce lower volumes of the sulphur oxides (SOx) linked to respiratory conditions. But while the east coast of Britain is protected by this zone, on the other side of the country there are no such restrictions. Dr Matt Loxham, a toxicologist at the University of Southampton, noted that besides gases like SOx ships also produce "more than their fair share" of ultrafine particles, which can penetrate deep into human tissue. "These very small particles contribute

Study shows more than 3,000 early mortalities linked to toxic fumes from ships around British coast

little to the mass [of pollution] but are thought to be associated with health effects in ways we haven't quite got a handle on yet," he said. The ICCT suggested the UK could seek to establish a new control zone to curb pollution, as European nations are currently trying to do in the Mediterranean. But while national governments can implement policies to cut pollution from cars, shipping is largely in the hands of the International Maritime Organisation – a UN agency based in London. "Even if you have very progressive stances from an individual government, it still needs to get into the IMO and be negotiated there," said Dr Rutherford. "There is a broader need to reform the IMO and get it moving in the right direction." A spokesperson from the IMO said new rules coming into force from 2020 will limit SOx even outside protected zones, which they predict will prevent more than half a million premature deaths around the world. However, these regulations will still not be as tight as those currently in place in the North Sea, with sulphur in fuel oil cut to just 0.5 per cent instead of the 0.1 per cent allowed in such zones.

The Independent, 11 March 2019

http://news.independent.co.uk

The Roundup row: is the world's most popular weedkiller carcinogenic?

2019-03-13

Producer Monsanto is facing thousands of lawsuits from customers who now have cancer. But not all experts are convinced of a link…

As a third-generation cotton farmer in Bakersfield, California, John Barton estimates that he sprayed thousands of gallons of the herbicide Roundup over the course of his 30-year working life. "My family were farming 1,000 acres of cotton, so we'd be out in the fields spraying it, and we'd get our pants wet, our shoes wet, our socks wet, and if the wind changed it would blow in our face," Barton tells me. "We did that spring, summer and fall for most of my life. There was really no regulation at the time that we were spraying Roundup; no one was offered any protection. But I didn't think anything of it, as they kept telling us how safe it was." By 'they', Barton is referring to Monsanto, the corporation that produces Roundup. Monsanto, which was acquired by the German pharmaceutical giant Bayer last year, is currently facing more than 9,000 lawsuits across the US from plaintiffs, mostly former gardeners and agricultural workers who believe that Roundup exposure caused their cancer. Last summer, former school groundskeeper Dewayne Johnson, who is terminally ill with non-Hodgkin lymphoma, won a landmark victory against the company when jurors ruled that Monsanto had failed to warn him of the health risks posed by Roundup. In the latest trial, which recently got under way

in San Francisco, Edwin Hardeman, who suffers from an aggressive form of non-Hodgkin lymphoma, is pursuing a similar verdict. Like Johnson and Hardeman, Barton has also developed non-Hodgkin lymphoma and is preparing to take legal action. "There's not really a lot of history of cancer in my family," he says. "I've been healthy all my life, so when I was diagnosed in 2015 it surprised me that all of a sudden, I had this disease. Now, as a father, I'm worried that I've exposed my sons, who are also farmers, to the same cancer." But while Johnson's legal triumph sent reverberations across the world last year, the very question of whether a weedkiller could be responsible for a person's cancer remains a divisive and highly charged topic across both the scientific and political worlds. In 2015, the International Agency for Research on Cancer (IARC) ruled that glyphosate – the active chemical within Roundup and many other popular weedkillers – was "probably carcinogenic". However, numerous other international agencies, including the European Chemical Agency and European Food Safety Authority (EFSA), continue to declare glyphosate as safe, and there are many scientific studies which have found no association with cancer. An estimated 6.1 billion kilos of glyphosate-based weedkillers were sprayed across gardens and fields worldwide between 2005 and 2014 (the most recent point at which data has been collected). That is more than any other herbicide, so understanding the true impact on human health is vital. So, what do we know, and why is there so much uncertainty?

'Where are all the bodies?' The inconclusive data

The reason glyphosate was thought to be completely safe for many years is that it works by inhibiting an enzyme pathway behind plant growth, which does not exist in humans. Since the introduction of Roundup-resistant GM food crops – genetically engineered to resist glyphosate – in the mid-1990s, farmers in the US have been able to use it in large quantities to get rid of weeds selectively, while in the UK it is used as the weedkiller of choice, outside of the growing season. But in the past two decades, some research has suggested that glyphosate may not be as benign as once thought. Last month, a high-profile collaborative study by three US universities reported that individuals with particularly high exposures to glyphosate-based herbicides, for instance those spraying it, could have a 41% increased relative risk of developing non-Hodgkin lymphoma. "The lifetime risk of developing NHL is usually around 1 in 50, so what this means is that in populations who are exposed to the very highest levels of glyphosate, it moves to around 1 in 35," explains Michael Davoren, a molecular toxicology researcher at the University of California.

"But the bulk of the risk, as with any cancer, is still going to be due to other factors, including in part strings of 'bad luck' mutations in a given set of cells." Multiple theories have been voiced as to why this increased risk might arise, such as the idea that glyphosate may mimic the behaviour of certain hormones. One study, by researchers in Thailand, suggested that by doing so, even low levels of glyphosate could increase the rate of breast cancer cell growth in petri dishes.

However, the trouble is, for every research paper that purports to show a link between glyphosate-based herbicides and cancer, there is another which finds the exact opposite. This hasn't been helped by the fact that many of the studies may not have been entirely objective. "A lot of the studies backing glyphosate have been funded by entities in a position to profit from the continuing sales," Davoren says. "And many of those which point towards significant risks are funded by groups who are either engaged in lawsuits against the makers of glyphosate, or are in the position to benefit from sales of glyphosate alternatives. So, it gets very, very tricky." But even some of the largest independent population-based studies have failed to find any sort of definitive proof. Last year, a two-decade-long analysis of data of nearly 45,000 farmworkers who applied glyphosate-based herbicides to their crops, conducted by the US National Institute of Health, showed no association with non-Hodgkin lymphoma or overall cancer risk. "This is the strongest argument that Monsanto has," says Deborah Kurrasch, a neuroscientist at the University of Calgary who has been researching glyphosate for several years. "If it's so damn bad, then where are all the bodies? The scientific evidence, as it stands right now, is not at all conclusive." But one of the factors that have left commentators suspicious of the potential toxicity of these herbicides has been incidents of combative corporate behaviour. In the latest trial, Monsanto has caused eyebrows to raise by obtaining a ban preventing attorneys for the plaintiffs from presenting information regarding its alleged influence on research.

The regulators versus the politicians

There is no question that the glyphosate debate has become highly politicised in recent years. Despite the limited evidence linking glyphosate to health risks, a European Citizens Initiative petition against its use in agriculture still garnered 1.3 million signatures, with the European Union's 2017 decision to license it for another five years sparking mass protests across the continent. In addition to cancer, environmental activists have claimed links between herbicide exposure and everything from coeliac disease to autism, while on the other side of the fence, regulatory agencies

blame an ongoing anti-GM agenda for driving public sentiment against this small molecule. If glyphosate is banned, campaigners will have struck another severe blow against GM crop production. "My personal perception is that glyphosate has become a symbol for the use of chemicals in agriculture and the way we produce food in Europe," says Dr Bernhard Url, executive director of EFSA. "When science meets values, things become complicated. So, when politicians are confronted with the opinion of EFSA that glyphosate is safe, they say, 'No, I don't want to hear that glyphosate is not carcinogenic because it doesn't fit into my world view. I want a world without agrochemicals and if you, EFSA, tell us that glyphosate is safe to be used, you must be corrupt.'" A 2016 study which found a 1,000% rise in the levels of glyphosate in our urine in the past two decades – suggesting that increasing amounts of glyphosate is passing through our diet – provoked further outrage. Except it isn't really clear whether that has any consequences at all for our health. An EFSA letter, published in the journal Nature, pointed out that glyphosate residues found in Italian pasta or German beer would only exceed known risk thresholds if someone were to consume their entire body weight's worth of those products in a single day. To try to understand any potential mechanisms for how glyphosate could be doing something untoward in our bodies, increasing numbers of studies have been conducted in cell lines, rodents, zebrafish and even worms, some of which have suggested that it could have the potential to disrupt basic biological processes such as mitochondrial function. "If anything needs to be looked at, it's whether glyphosate has some toxicity at a metabolic level," Kurrasch says. "If you look at a variety of central nervous system (CNS) disorders, all of those have been linked to mitochondrial dysfunction." However, so far, no link has been found between glyphosate exposure and CNS disorders in humans. The same is true for theories which speculate as to whether glyphosate passing through our gut may perturb the microbiome, inhibiting beneficial bacteria, and so promoting the growth of inflammation-inducing pathogenic bacteria. These theories link glyphosate to inflammatory disorders such as intestinal cancer, yet to date, no such associations have been found in population studies. The glyphosate debate has even moved to the insect world. While glyphosate has been known for many years to pose health risks to fish, and as such, its use near water is strictly regulated, a paper last year claimed that it could pose a risk to bees. The study found that glyphosate levels in flowers could affect the bee microbiome, potentially affecting their health. However, given that the study examined just 15 bees, this also remains somewhat tenuous.

The backlash

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With the legal battles over glyphosate's alleged link to non-Hodgkin lymphoma set to continue over the coming years, scientists and regulatory bodies alike agree that the only way to try to come to a common consensus about whether it poses a genuine threat is to transparently share their data. According to Davoren, "The only way this debate is going to be settled is with a large amount of further research built on a philosophy of open data, where everyone says, 'OK, this is what we found, here is the exact way we did it, here is our raw data, and everybody take a look to be sure that you see there's no bias.'" However, such is the political pressure surrounding the use of glyphosate that many strongly suspect it will begin to be phased out, regardless of the scientific conclusions, in the near future. French authorities banned the sale of a form of Roundup earlier this year. President Macron has vowed to outlaw glyphosate-based herbicides altogether by 2021, and both Germany and Italy are reportedly considering following suit. Following Brexit, there is also the potential that the UK, too, will change its current stance on the use of glyphosate in agriculture. A 2017 House of Commons briefing paper on glyphosate suggested that ministers at the Department for Environment, Food and Rural Affairs may well take a different approach from the EU. EFSA is pressing for further discussions about the potential consequences on farming and the food industry of banning glyphosate before drastic measures are taken, but whether its call is heeded remains to be seen. "There needs to be meaningful discussions about this on a political stage," Url says. "Do we want to use agrochemicals in Europe or not, and if so, under which conditions? What would a world without glyphosate and herbicides mean for agriculture and biodiversity, food prices, consumers? And what are the risks and benefits?" But for Barton and the many plaintiffs, there remains no doubt in their minds that the high levels of glyphosate exposure, which they encountered throughout their working lives, have contributed to their illnesses. "There was never a warning on that product to be careful when you use it, that you need to be protected, because there could be a danger," Barton says. "I believe Monsanto put profit above people, and they've got away with it for all these years."

Everyday dangers

International Agency for Research on Cancer (IARC) is funded by the World Health Organization and its research is regarded as the benchmark for determining what agents may be cancer-causing. Some examples of its classifications below…

Group 1 carcinogens

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Carcinogenic to humans. 120 agents, including:

- alcoholic drinks
- asbestos
- diesel engine exhaust emissions
- indoor tanning
- tobacco
- x-rays

Group 2A

Probably carcinogenic to humans. 82 agents, including:

- red meat
- indoor emissions from wood-burning stoves
- glyphosate
- shift-work that involves circadian disruption
- petroleum refining (occupational exposures in)
- frying – emissions from high temperature

Group 2B

Possibly carcinogenic to humans. 311 agents, including:

- dry cleaning (occupational exposures in)
- firefighting (occupational exposures in)
- aloe vera
- bracken fern
- ginkgo biloba extract
- lead

The Guardian, 10 March 2019

http://www.guardian.com

Curiosities

China Experiences a Fracking Boom, and All the Problems That Go With It

2019-03-13

The first earthquake struck this small farming village in Sichuan Province before dawn on 24 February. There were two more the next day. Sichuan is naturally prone to earthquakes, including a major one in 2008 that killed nearly 70,000 people, but to the rattled villagers of Gaoshan, the cause of these tremors was human-made. "The drilling," Yu Zhenghua said as she tearfully surveyed her damaged home, still officially uninhabitable five days later. The drilling Ms. Yu referred to was hydraulic fracturing, or fracking. The technology, which has revolutionised the production of natural gas and oil in the United States, has created a boom in China, too, and with it many of the controversies that have dogged the practice elsewhere. In the hours after the quakes, thousands of residents converged outside the main government building in Rong County to protest widespread fracking in the rolling hills and valleys here now yellowing with the flowering of rapeseed. The protesters jostled with security guards along a sliding metal gate and dispersed only after officials announced they had suspended fracking operations of a regional subsidiary of China National Petroleum Corporation, the country's largest oil and gas producer. China, like the United States and other countries, has embraced the fracking revolution in hopes of weaning itself from its dependence on foreign energy sources. But the public fury that unexpectedly boiled over in Gaoshan underscores the social and environmental challenges the country must overcome — even in a tightly controlled political system. "Sichuan is a major earthquake zone, so there is clearly a risk," said Philip Andrews-Speed, a geologist with the Energy Studies Institute of the National University of Singapore. He added that the government should conduct a thorough and transparent study of causes of the temblors in order to reassure those who live nearby. The three earthquakes killed two people and wounded 13. More than 20,000 homes in three villages suffered damage and nine collapsed completely, according to a statement by the county. About 1,600 people were displaced, forced to move in with relatives or to live temporarily in 470 blue tents distributed by the authorities. The suspension of operations — which remains in effect — stilled 15 sites in the area affected by the quakes, pending a survey by officials from Sichuan Province, according to an official for the Rong County government, Huang Jing. It has not affected fracking operations elsewhere in the region, a centre of the fracking boom. China National Petroleum alone has invested $4 billion in fracking shale gas in the Sichuan Basin over the last decade, Xinhua, the state-run news agency,

reported last November. China National Petroleum declined to comment on the issue. The nation's other major oil and gas producer, Sinopec, which also operates in the province, also declined to comment. The website for the regional subsidiary of China National Petroleum, however, later shared a blog post suggesting that the suspension in Rong County was unnecessary. Compared to the loss of economic development, the post said, seismic activity caused by drilling for shale gas was "the lesser of two evils." For many residents of the area, that choice is far from clear.
Wu Shirong was in the shower when the second quake struck on 25 February. "This was the scariest one," he said, though by magnitude the one that followed four and a half hours later was the strongest of the three, measuring 4.9 on the Richter scale, according to China's geological service. Cracks spread across the ceiling of his house, which was declared unsafe. He is now living in one of the tents with his in-laws in the driveway outside. "Where can I sleep if I don't sleep here?" he said. Yu Zhenghua showing visitors cracks that have appeared along the walls of her house. "My house was built only 12 years ago," she said, "and now it is like this." Ms. Yu's house appeared more badly damaged. The retaining wall that holds up her property along a steep hillside buckled and seemed on the verge of collapse. Deep cracks gouged the stuccoed brick walls of the two-story house her son built with his earnings. Her son and daughter-in-law, like many Chinese, moved to a city in the southern region of Guangxi for work. "My house was built only 12 years ago," she said, "and now it is like this." The local authorities have promised to repair the damage. They have not acknowledged any link between the tremors and fracking, which involves injecting chemicals and sand at high pressure into wells drilled in shale formations to break up the rock and release gas and oil. "The relationship between earthquakes and local industrial exploitation cannot be determined," the county government wrote on its website.
In China, as in other countries, the link remains the subject of debate. Supporters of the technology claim there is no direct connection, though studies have shown otherwise. Fracking and related activity increases pressure underground, which can cause existing faults to slip. Fracking has nonetheless vastly expanded the natural resources that can be recovered underground, making the technology irresistible to China, which is highly dependent on energy imports, as the United States once was. China sits on top of the largest technically recoverable reserves of shale gas in the world, according to the United States Energy Information Administration, and the government has set ambitious goals for expanding production in the years ahead. There are many reasons. In addition to energy independence, the increased use of natural gas could help China meet its international commitments to reduce emissions that contribute to climate

change. The transition to gas has already helped reduce pollution — at least in the northeast, where the authorities have phased out the use of coal to heat homes. China's hopes to replicate the American fracking boom, however, have hit significant stumbling blocks. Shale deposits tend to be deeper here — 3.5 kilometres in Rong County, or more than two miles down. That makes them more expensive to tap. The process also requires a lot of water, which is scarce in some regions. Perhaps most importantly, China is much more densely populated, and many of its best shale deposits are in crowded places. Those include Sichuan, which has a population of more than 80 million. Since reserves were discovered there in 2009, scores of fracking sites have appeared — with virtually no public input, given the authoritarian nature of the government. The 15 platforms in Rong County have 39 separate wells being drilled or already in operation. They have appeared within a 10-kilometer circle around the county's main town, surrounded by fencing and filled with trucks and equipment. Because of the heavy equipment involved, the roads to the sites are rutted and, when it rains, nearly impassable because of mud. Long black tubes extend across once scenic valleys and terraced fields. As in other places, Rong County residents say they noticed an increase in tremors and quakes after production began. The latest appeared to inflame discontent that had long been simmering. A video of the protest outside the government building was first published by Radio Free Asia. Local residents also voiced complaints on Weibo, a social media site like Twitter. "What on earth do you want from us?" one woman wrote. "Will you take the matter seriously only when there's loss of life?"

New York Times, 8 March 2019

http://www.nytimes.com/

The resignation of FDA Commissioner Scott Gottlieb could stymie efforts to get young people off tobacco.

What the Departure of Vaping's Most Powerful Opponent Means for American Teens

2019-03-13

Parents hoping to pry the vapes from their teenagers' hands now might face an even more uncertain road ahead. Just days after Food and Drug Administration Commissioner Scott Gottlieb reportedly delivered a plan to curtail e-cigarettes' booming sales to the White House, he announced that he'll be leaving his role as the head of the agency in April. Gottlieb's announcement was unexpected—he had publicly contradicted rumours of his departure as recently as two months ago—and it could be an inflection point for both anti-tobacco advocates and those who see e-cigarettes as an important harm-reduction tool in the fight against

smoking. With rates of adolescent e-cigarette use continuing to soar, though, the biggest impact of Gottlieb's sudden departure could be felt among teens themselves. In Donald Trump's administration, Gottlieb's tenure as the head of the FDA has been something of an anomaly. Because of the commissioner's professional history as a pharmaceutical consultant, industry watchdogs were initially concerned that he might spurn regulation and make the agency more business-friendly, as Trump's appointees at the Environmental Protection Agency and Interior Department have done. Instead, Gottlieb has largely done the opposite: He's been outspoken in his intent to regulate the availability of e-cigarettes, reduce tobacco levels in combustible cigarettes to nonaddictive levels, ameliorate the harms of the opioid epidemic, and lower consumer prices for prescription drugs. Gottlieb's measures against teen vaping are some of the FDA's most high-profile moves since he joined in May 2017. On the heels of recent research indicating that almost 40 percent of American high-school seniors vaped that year, the agency proposed guidelines that would take flavoured e-cigarette cartridges out of most brick-and-mortar retailers in America, including convenience stores. Flavoured vape products, the agency argued, were especially easy entry points for teen use, and they weren't necessary in order for e-cigarettes to be used as effective alternatives to combustible cigarettes for adult smokers. That move was heralded as a step in the right direction by people such as Robert Jackler, a Stanford University professor who researches how e-cigarettes like the ultra-popular Juul are marketed to young people. Gottlieb's plans to leave the agency worry him. "I hope that his successor shares a similar passion for protecting youth from nicotine addiction," Jackler said in an emailed statement. "The upward spike in tobacco stocks is a worrisome sign that the industry anticipates relief from regulation." Indeed, stocks for the tobacco giants Altria and British American Tobacco did inch northward after Gottlieb's announcement, although no successor for Gottlieb's role has been named. Bonnie Halpern-Felsher, a paediatrics professor and tobacco-use researcher also at Stanford, feels similarly. "I am shocked and saddened by FDA Commissioner Gottlieb's resignation," she says. Although she emphasised that little is known about what's to come at the agency, losing a strong advocate is always cause for concern. "I worry, since he has definitely been leading the way in proposing vaping regulation, recognizing and trying to reduce the youth-vaping epidemic," Halpern-Felsher says. Meanwhile, Gregory Conley, the president of the American Vaping Association, criticised Gottlieb's lack of effort on behalf of small- and medium-size e-cigarette entrepreneurs. "We are hopeful that the next FDA Commissioner will undertake real efforts to repair our country's

broken nicotine regulatory system," he said in a statement released on Twitter. Some conservatives have been critical of what they see as the current FDA's overly meddlesome approach to vaping businesses, which they argue drives adult smokers away from alternatives that could save their life. For Gottlieb's part, he has continued to be outspoken, even after announcing his departure. In a live interview with The Hill on Facebook, he emphasised that his decision to leave the FDA was strictly out of a desire to spend more time with his family in Connecticut, and that he intended to put his last few weeks on the job to good use. "I am extremely confident that the policy that was reported on Friday will be out very shortly," Gottlieb said, referring to rumours late last week that the FDA's restriction on flavoured vape cartridges had been turned over to the White House for final approval. Gottlieb also said that he and the current administration hope to keep the current FDA team intact, which could help assuage fears that the agency's perspective on regulation will change radically in the near future. That's likely good news for those worried about the health of American adolescents: Little is known about what's actually in vape liquid or what high nicotine concentrations, such as those in Juul cartridges, could mean for very young users' future well-being. Although the FDA now takes a strong position on adolescent use of e-cigarettes, among anti-tobacco advocates, the agency has been criticised for being slow to address the growing problem of teen vaping. Juul is by far the most popular vape product among young Americans, and since it came to market in mid-2015, its broad availability has caused a regulatory headache for those trying to curb its appeal. For most of its existence, kids could buy Juuls and their replaceable pods relatively easily from convenience stores and vape shops with lax ID practices, from online retailers, and—maybe most troublingly—from enterprising older classmates who sell them in schools. That broad and relatively easy access, coupled with Juul's small, easily concealable size, has led millions of kids (many of whom don't even realise it contains nicotine) into at least casual tobacco use. Gottlieb also said in his interview with The Hill that he's optimistic about the conversations he's had so far about who will take on his position, and that e-cigarettes are an issue that person won't be able to ignore. "You do not want kids initiating on these," he says. "If we start seeing tobacco use rates in this country of 40 to 45 percent, and we start seeing combustible use go back up, I think you're going to have a groundswell of people who are going to demand action."

The Atlantic, 6 March 2019

https://www.theatlantic.com

Curiosities

Long-term obesity tied to higher dementia risk in healthy older adults

2019-03-13

Healthy older adults who have been obese for years may be at higher risk of developing dementia than their peers who aren't overweight, research from the UK suggests. The study team followed two groups of dementia-free adults aged 65 to 74 years for up to 15 years. One group, considered healthy, included 257,523 non-smokers who didn't have cancer, heart failure or multiple chronic health problems; another group of 161,927 adults, deemed unhealthy, did smoke or have serious chronic medical issues. Over the first decade of the study, healthy people who were obese or overweight were less likely to develop dementia than healthy people at a normal weight, the study found. But after that, obesity was associated with a 17 percent higher risk of dementia and being heavier no longer appeared to be protective. "When we looked long-term, being obese was definitely associated with increased risks of dementia," said senior study author David Melzer of the University of Exeter in the UK. People with obesity often have other health problems like diabetes and high blood pressure that can independently increase the risk of dementia, previous research has found. But results regarding the connection between obesity and dementia have been mixed, with some previous studies suggesting that this excess weight might actually be protective. In the current study, 9,774 people in the "healthy" group were diagnosed with dementia. Slightly more than half of the dementia patients had lost at least 2.5 kilograms (5.5 pounds) during the decade prior to their diagnosis. Weight loss prior to the dementia diagnosis might mask the connection between obesity and cognitive decline, Melzer said by email. Alzheimer's disease, the main cause of dementia, can develop slowly over up to 20 years before people get diagnosed, Melzer noted. "The same is true of damage to the arteries in the brain, which also contributes to dementia," Melzer said. "This slow development of dementia makes it difficult to separate real risk factors from the effects of the disease." Interestingly, obesity was associated with a lower short-term and long-term risk of dementia for the unhealthy group in the study. A total of 6,070 individuals in the unhealthy group developed dementia. "In general, losing weight, being more physically active, and getting blood pressures and cholesterol levels under control should make a big difference for dementia risk, plus risks of diabetes and heart disease," Melzer said. The study wasn't designed to prove whether or how obesity might directly cause dementia in later years. Another limitation is that researchers lacked data to examine the connection between obesity and

Healthy older adults who have been obese for years may be at higher risk of developing dementia than their peers who aren't overweight, research from the UK suggests.

specific forms of dementia like Alzheimer's disease, the authors note in Age and Ageing. In a separate study in the same journal, researchers led by Alexander Allen of the London School of Hygiene and Tropical Medicine also examined the connection between overweight and dementia, and also cast doubt on the idea that obesity is protective. The researchers analysed the link between excess belly fat in middle age and the risk of death from dementia over the next 40 years in about 19,000 male civil servants participating in a long-term health study. They found that weight loss over 30 years, starting in middle age, was associated with an increased risk of dementia in old age. Having excess fat in old age, however, was tied to a lower risk of dementia. While that may appear to suggest a protective effect of extra weight, in fact, the strongest connection, between weight loss over time and an eventual dementia diagnosis, points to the symptoms of developing dementia contributing to the weight loss, Allen and colleagues write. "These effects may reflect changes in appetite or other aspects of behaviour that result in reduced energy intake," they note. "Thus, claims from previous studies that underweight increases the risk of dementia may be an artefact of the effects of reverse causality." Allen didn't respond to requests for comment. "Regular weight checks could provide an easily measured marker for risk of frailty and subsequent detection of dementia," Allen and colleagues write. "Whether this could allow early interventions to improve dementia outcomes could also merit further investigation."

Reuters Health, 8 March 2019

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

People with chronic health problems who suffer from depression may find their mood improve when they do aerobic exercise, a research review suggests.

Aerobic exercise eases depression, even in chronically ill

2019-03-13

People with chronic health problems who suffer from depression may find their mood improve when they do aerobic exercise, a research review suggests. Patients with long-term medical issues are two to three times more likely to develop depression than the general population, researchers noted in the British Journal of Sports Medicine, online February 6. When these patients do become depressed, their chronic illnesses often worsen and their risk of dying goes up. For the current study, researchers examined data from 24 studies with a total of 4,111 patients living with chronic illness and symptoms of depression. All of the smaller studies randomly assigned some patients to do aerobic exercise and others to comparison groups that just got usual medical care. Patients

who exercised at least two to three times a week were more likely to see a reduction in depression symptoms than people who didn't do aerobic exercise at all, the study found. There was a more pronounced effect when people exercised four to five times a week, but this difference was too small to rule out the possibility that it was due to chance. "One of the key messages that we see often around aerobic exercise is: something is better than nothing and more is better than less, said senior study author Dr. Simon Bacon of Concordia University in Montreal, Canada. "To some degree our study reinforces this point," Bacon said by email. Most exercise guidelines recommend 150 to 250 minutes a week - and up to an hour a day - of moderate intensity aerobic exercise to prevent weight gain or to achieve modest weight loss. Depression symptoms eased by a similar amount regardless of whether people in the exercise groups met activity guidelines of at least 150 minutes a week. "This suggests that even short regular bouts of aerobic exercise may be enough to reduce depression," Bacon said. Exercise programs in the smaller studies lasted from 4 to 24 weeks, and half of them were at least 12 weeks long. Half of the workout programs also involved at least three sessions a week. Each workout lasted an average of 42 minutes, although sessions ranged from 20 to 80 minutes. Some studies only included supervised workouts at gyms, while others started out with this approach and then transitioned patients to home workouts. Even though these smaller studies were controlled experiments, the types of exercise programs and patients included were so varied that researchers couldn't determine whether any specific workout program might be ideal for patients based on their specific medical issues. Still, the results add to evidence suggesting that exercise can improve mental health and minimise the risk of developing psychiatric problems, said Dr. Adam Chekroud, a researcher at Yale University in New Haven, Connecticut, who wasn't involved in the study. "Overall, exercising for 30-60 minutes 3-4 times a week is generally a great target, but people do benefit from lighter exercise regimes that might be shorter in duration or lower in intensity," Chekroud said by email. "If folks are not able to exercise, walk, or swim, there are still lots of ways to help improve their mental health," Chekroud added. "Options include talk therapy, where you speak to a counsellor and learn ways of handling your thoughts, feelings, and emotions; or medications that can also help reduce symptoms.

Reuters Health, 7 March 2019

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

Curiosities

Norway's Insanely Efficient Scheme Recycles 97% of All Plastic Bottles They Use

2019-03-13

When it comes to recycling plastic waste, Norway is ahead the pack. In fact, the Scandinavian nation has virtually lapped the rest of the world. Through an organisation called Infinitum, Norway has created one of the most efficient and environmentally friendly ways of recycling plastic bottles, and the results are so impressive that many nations are following suit. According to The Guardian, the scheme has allowed Norway to recycle 97 percent of all its plastic bottles, with less than one percent ending up in the environment. What's more, 92 percent of the bottles recycled yield such high-quality material, it can be used again in drink bottles. In some cases, the system has already reused the same material more than 50 times. That's a remarkable achievement, especially considering that worldwide, 91 percent of plastic produced isn't recycled, and 8 million metric tons end up in the ocean every year. In the US, the recycling rate for plastic bottles is around 30 percent. In the United Kingdom, it's somewhere between 20 and 45 percent. So, what is Norway doing differently? To put it simply, the nation has given recycling a value it didn't once have. Today, it's often cheaper to create new plastic than it is to recycle old plastic, so without a financial incentive, why would companies and consumers bother to do the right thing for the environment? The answer is, of course, money. Norway's model is based on a loan scheme, which means when a consumer buys a plastic bottle, they are charged a small additional fee equivalent to about 13 to 30 US cents. This fee can then be redeemed in a number of ways. Consumers can either take it to a 'reverse vending machine' which returns the money after scanning the barcode of the deposited bottle, or they can return it to various small shops and gas stations for cash or store credit. These shop owners also receive a small fee for each bottle they recycle, and some argue it has even increased their business. "We want to get to the point where people realise they are buying the product but just borrowing the packaging," Kjell Olav Maldum, the CEO of Infinitum, told The Guardian. But it's not just consumers that the government is targeting. At the same time, the country has also put an environmental tax on plastic producers - one that can be reduced with greater improvement. If recycling is above 95 percent nationwide, then every producer, no matter what, is exempt from the tax. And while this may sound like a difficult target to meet, it has been reached every year for the past seven years. Since the advent of this unique scheme, according to the company, Infinitum has been visited by representatives from many countries - including Scotland, India, China,

When it comes to recycling plastic waste, Norway is ahead the pack.

Australia and others - all of whom are interested in following the nation's lead. Germany and Lithuania are some of the only countries that can compete with Norway, and they both use similar systems. Nevertheless, even in Norway, there's still room for improvement. This year, Infinitum estimates that 150,000 bottles will not be returned, and if they had, it would have saved enough energy to power 5,600 households for the year. That's a pretty good reason to recycle.

Science Alert, 10 March 2019

http://www.sciencealert.com.au

South Korea And China Are Using Artificial Rain to 'Wash Away' Air Pollution

2019-03-13

Air pollution is a major problem no matter where you live, but it can get particularly bad in Seoul, the capital of South Korea – and so the government authorities are taking drastic action to try and deal with the smog that settles over the city. The latest plan from President Moon Jae-in is to create artificial rain showers to effectively wash the air pollution out of the sky. It's a strategy we've seen before, but there's still no solid evidence that it actually works. The idea is called cloud seeding: specific chemicals are released into the air, usually by planes, with the intention of encouraging water droplets to form. The rain that's created then attracts and pulls polluting aerosol particles out of the sky as it falls. That's the theory, anyway. Previous experiments have been inconclusive as to whether cloud seeding actually works, and South Korea itself made a failed attempt to force air-clearing showers back in January. So far, the technique has been used to try and ensure good weather for the Beijing Olympics and to solve water shortages, but specific types of clouds have to be present to begin with in order to give precipitation an artificial boost. Aside from cloud seeding, there's also an ongoing debate about the long-term effectiveness of using water to clear away pollution. Rain can clear the air of polluting particles, but to what extent and how effective it can be is something scientists are still investigating. Nevertheless, South Korea is going to give it another go. The project is being undertaken in partnership with China, as a lot of the fine dust particles clogging up the atmosphere are originating from the neighbouring country. Apparently, the artificial rain showers will be generated above the Yellow Sea, to the west of the Korean Peninsula. It's been a particularly bad week for air pollution in the region. The Associated Press reports that fine dust concentration levels were 136 micrograms per cubic metre in Seoul on

In South Korea, the government plan to create artificial rain showers to effectively wash the air pollution out of the sky.

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Wednesday – with 75 micrograms per cubic metre considered "very bad" by the National Institute of Environmental Research in South Korea. That's in relation to ultrafine particles smaller than 2.5 micrometres in diameter, or PM 2.5. The World Health Organisation (WHO) recommends keeping PM 2.5 levels below 25 micrograms... so you can see the severity of the problem. The government is also taking steps to close down older coal-burning power plants, and to make more money available for air purifiers in schools. Whatever the effectiveness or otherwise of using artificial rain to clear away pollution, what's clear is that action needs to be taken, and fast. According to WHO stats released last year, 93 percent of kids worldwide under 15 are breathing polluted air. Ultimately, combating air pollution in the long term – and all the damage to our health and the natural world that goes with it – is going to involve changes in the way we live and produce our energy.

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http://www.sciencealert.com.au

Here's What Happens to Your Brain And Body if You Give Up Sugar For Lent

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Anyone who knows me also knows that I have a huge sweet tooth.

Anyone who knows me also knows that I have a huge sweet tooth. I always have. My friend and fellow graduate student Andrew is equally afflicted, and living in Hershey, Pennsylvania – the "Chocolate Capital of the World" – doesn't help either of us. But Andrew is braver than I am. Last year, he gave up sweets for Lent. I can't say that I'm following in his footsteps this year, but if you are abstaining from sweets for Lent this year, here's what you can expect over the next 40 days.

Sugar: natural reward, unnatural fix

In neuroscience, food is something we call a "natural reward". In order for us to survive as a species, things like eating, having sex and nurturing others must be pleasurable to the brain so that these behaviours are reinforced and repeated. Evolution has resulted in the mesolimbic pathway, a brain system that deciphers these natural rewards for us. When we do something pleasurable, a bundle of neurons called the ventral tegmental area uses the neurotransmitter dopamine to signal to a part of the brain called the nucleus accumbens. The connection between the nucleus accumbens and our prefrontal cortex dictates our motor movement, such as deciding whether or not to taking another

bite of that delicious chocolate cake. The prefrontal cortex also activates hormones that tell our body: "Hey, this cake is really good. And I'm going to remember that for the future." Not all foods are equally rewarding, of course. Most of us prefer sweets over sour and bitter foods because, evolutionarily, our mesolimbic pathway reinforces that sweet things provide a healthy source of carbohydrates for our bodies. When our ancestors went scavenging for berries, for example, sour meant "not yet ripe," while bitter meant "alert – poison!" Fruit is one thing, but modern diets have taken on a life of their own. A decade ago, it was estimated that the average American consumed 22 teaspoons of added sugar per day, amounting to an extra 350 calories; it may well have risen since then. In 2014, one expert suggested that the average Briton consumes 238 teaspoons of sugar each week. Today, with convenience more important than ever in our food selections, it's almost impossible to come across processed and prepared foods that don't have added sugars for flavour, preservation, or both. These added sugars are sneaky – and unbeknown to many of us, we've become hooked. In ways that drugs of abuse – such as nicotine, cocaine and heroin – hijack the brain's reward pathway and make users dependent, increasing neuro-chemical and behavioural evidence suggests that sugar is addictive in the same way, too.

Sugar addiction is real

"The first few days are a little rough," Andrew told me about his sugar-free adventure last year. "It almost feels like you're detoxing from drugs. I found myself eating a lot of carbs to compensate for the lack of sugar." There are four major components of addiction: bingeing, withdrawal, craving, and cross-sensitisation (the notion that one addictive substance predisposes someone to becoming addicted to another). All of these components have been observed in animal models of addiction – for sugar, as well as drugs of abuse. A typical experiment goes like this: rats are deprived of food for 12 hours each day, then given 12 hours of access to a sugary solution and regular chow. After a month of following this daily pattern, rats display behaviours similar to those on drugs of abuse. They'll binge on the sugar solution in a short period of time, much more than their regular food. They also show signs of anxiety and depression during the food deprivation period. Many sugar-treated rats who are later exposed to drugs, such as cocaine and opiates, demonstrate dependent behaviours towards the drugs compared to rats who did not consume sugar beforehand. Like drugs, sugar spikes dopamine release in the nucleus accumbens. Over the long term, regular sugar consumption actually changes the gene expression and availability of dopamine receptors in both the midbrain

and frontal cortex. Specifically, sugar increases the concentration of a type of excitatory receptor called D1, but decreases another receptor type called D2, which is inhibitory. Regular sugar consumption also inhibits the action of the dopamine transporter, a protein which pumps dopamine out of the synapse and back into the neuron after firing. In short, this means that repeated access to sugar over time leads to prolonged dopamine signalling, greater excitation of the brain's reward pathways and a need for even more sugar to activate all of the midbrain dopamine receptors like before. The brain becomes tolerant to sugar – and more is needed to attain the same "sugar high".

Sugar withdrawal is also real

Although these studies were conducted in rodents, it's not far-fetched to say that the same primitive processes are occurring in the human brain, too. "The cravings never stopped, [but that was] probably psychological," Andrew told me. "But it got easier after the first week or so." In a 2002 study by Carlo Colantuoni and colleagues of Princeton University, rats who had undergone a typical sugar dependence protocol then underwent "sugar withdrawal". This was facilitated by either food deprivation or treatment with naloxone, a drug used for treating opiate addiction which binds to receptors in the brain's reward system. Both withdrawal methods led to physical problems, including teeth chattering, paw tremors, and head shaking. Naloxone treatment also appeared to make the rats more anxious, as they spent less time on an elevated apparatus that lacked walls on either side. Similar withdrawal experiments by others also report behaviour similar to depression in tasks such as the forced swim test. Rats in sugar withdrawal are more likely to show passive behaviours (like floating) than active behaviours (like trying to escape) when placed in water, suggesting feelings of helplessness. A study published by Victor Mangabeira and colleagues in Physiology & Behavior in 2015 reports that sugar withdrawal is also linked to impulsive behaviour. Initially, rats were trained to receive water by pushing a lever. After training, the animals returned to their home cages and had access to a sugar solution and water, or just water alone. After 30 days, when rats were again given the opportunity to press a lever for water, those who had become dependent on sugar pressed the lever significantly more times than control animals, suggesting impulsive behaviour. These are extreme experiments, of course. We humans aren't depriving ourselves of food for 12 hours and then allowing ourselves to binge on soda and doughnuts at the end of the day. But these rodent studies certainly give us insight into the neuro-chemical underpinnings of sugar dependence, withdrawal, and behaviour.

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Through decades of diet programmes and best-selling books, we've toyed with the notion of "sugar addiction" for a long time. There are accounts of those in "sugar withdrawal" describing food cravings, which can trigger relapse and impulsive eating. There are also countless articles and books about the boundless energy and new-found happiness in those who have sworn off sugar for good. But despite the ubiquity of sugar in our diets, the notion of sugar addiction is still a rather taboo topic. Are you still motivated to give up sugar for Lent? You might wonder how long it will take until you're free of cravings and side-effects, but there's no answer – everyone is different and no human studies have been done on this. But after 40 days, it's clear that Andrew had overcome the worst, likely even reversing some of his altered dopamine signalling. "I remember eating my first sweet and thinking it was too sweet," he said. "I had to rebuild my tolerance."

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New pill shows early promise for blocking many strains of flu

2019-03-13

Researchers report they've developed an experimental oral medicine that protects mice from a wide range of influenza viruses.

The flu season is at its height in the Northern Hemisphere, but—as many are discovering—seasonal flu vaccines don't always provide complete protection, because unexpected flu strains show up unannounced. Now, researchers report they've developed an experimental oral medicine that protects mice from a wide range of influenza viruses. If it works in humans, it could lead to a new pill to fight one of the deadliest infection's humanity faces. Every year, influenza causes a severe illness in some 3 million to 5 million people worldwide and kills up to 650,000, according to the World Health Organization. Medicine's primary defence against the flu is the seasonal flu vaccine, an injected cocktail of killed viruses designed to prod the immune system to produce antibodies. Those antibodies disable the flu strains deemed most likely to circulate that season. But sometimes unforeseen strains end up spreading instead, rendering the vaccine less effective. Normally, antibodies target an individual strain of flu. But in 2008, researchers discovered a class of so-called broadly neutralising antibodies (bnAbs) in humans that can bind to and disable multiple flu strains at once. Detailed studies of one the best of these bnAbs, called CR6261, showed it binds to the stem portion of a mushroom-shaped hemagglutinin (HA) protein on the surface of the virus. This portion of the protein is virtually identical in multiple flu strains and is essential for

enabling the virus to fuse with the membranes of cells it infects. Close-up images of CR6261 bound to the HA stem revealed the antibody binds by holding on to five tiny indentations in the stem, much as a rock climber uses minute toe and finger holds to hang onto an otherwise sheer granite cliff face. "CR6261 targets all five pockets up and down the stem," says Ian Wilson, a structural biologist at Scripps Research in San Diego, California. In 2011 and 2012, researchers led by Wilson and David Baker at the University of Washington in Seattle used computer design techniques to create a much smaller protein called HB80.4 that binds to HA's stem using the same holds and blocks viral fusion. But proteins typically don't work as oral medicines because digestive enzymes break them down in the stomach. Now, Wilson, Maria van Dongen, a drug discovery expert at the Janssen Pharmaceutical Companies of Johnson & Johnson in Leiden, The Netherlands, and their colleagues have used the previous discovery of HB80.4 to help them find small molecules that do the same thing. Van Dongen and her team created a lab test in which they first bound HB80.4 to the flu virus's HA stem. They then screened 500,000 small molecules from the company's proprietary library to see whether any bound to the same site so tightly that they essentially pushed HB80.4 out of the way. They initially got some 9000 hits, which they whittled down to a top binder. They tweaked this compound further to create JNJ4796, a molecule containing six rings in a line, which not only binds better than HB80.4 to the HA stem's indentations but has improved properties for acting as a drug, such as increased solubility in blood. Van Dongen's team showed the would-be drug blocks a group of flu viruses from infecting mouse and human cells in a petri dish. And studies in mice given the drug orally showed it prevented animals from getting sick after being exposed to lethal doses of multiple strains of the flu, the researchers report today in Science. "It's a beautiful story," showing how scientists have steadily progressed toward coming up with a new antiflu drug, says Yoshihiro Kawaoka, a virologist at the University of Wisconsin in Madison. If the drug proves safe and effective in humans, it would join two approved oral medications—Tamiflu and Xofluza—that can help fight the flu. Unlike JNJ4796, which blocks viruses from entering cells, the approved drugs block viruses from spreading once they have already infected cells. But viruses have already shown signs of developing resistance to the current drugs. "It's important to have drugs against different targets," Kawaoka says. That said, JNJ4796 doesn't work against all flu viruses. The compound blocks influenza A group 1 viruses, which includes the H1N1 virus that accounts for nearly half of flu infections this season. But it doesn't block two other classes—influenza A group 2 or influenza B viruses—that account for the rest of this year's infections. Nevertheless, Florian Krammer,

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a virologist at the Icahn School of Medicine at Mount Sinai in New York City, says the "elegant" screening approach Van Dongen's team used to identify the initial HA binder could also help find drug leads that bind the other viral classes. The same strategy could even work for finding novel drugs to block other viral diseases, such as Ebola, he says. "This is just the start."

Science, 7 March 2019

http://sciencemag.org/

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Biosynthesis of iron oxide nanoparticles using leaf extract of Ruellia tuberosa: Antimicrobial properties and their applications in photocatalytic degradation

Ca2+ protect zebrafish embryos from water acidification

Endocrine-disrupting chemicals impair the innate immune prophenoloxidase system in the intertidal mud crab, Macrophthalmus japonicus

MEDICAL RESEARCH

Effects of defined mixtures of POPs and endocrine disruptors on the steroid vmetabolome of the human H295R adrenocortical cell line

Endocrine-disrupting chemicals: Effects on neuroendocrine systems and the neurobiology of social behaviour.

Detection and Analysis of Endogenous Polar Volatile Organic Compounds (PVOCs) in Urine for Human Exposome Research

A monoclonal antibody against Lates calcarifer vitellogenin and a competitive ELISA to evaluate vitellogenin induction after exposure to xenoestrogen

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Early prediction of liver carcinogenicity due to occupational exposure to pesticides

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