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

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ASIA PACIFIC

Case studies — guides to categorising chemicals

2018-05-18

To help people understand how the proposed categorisation process for new industrial chemicals will work under the new Australian Industrial Chemicals Introduction Scheme (AICIS), the National Industrial Chemicals notification & Assessment Scheme (NICNAS) have put together a range of case studies. The case studies cover typical scenarios for introducing cosmetic and non-cosmetic new chemicals. They show how introducers would categorise chemicals as exempted or reported under the new scheme.

What's in the case studies

- Checklists of the information you will need for categorisation;
- Summary of the steps needed to categorise the chemical introduction;
- Walk through each step 1-6, including:
 - determining the indicative risk for human health and environment
 - determining the introduction category

Finally, NICNAS explain what happens next and give a brief comparison for the same introduction under the current legislation.

Download a case study

Non-cosmetics case studies

- Low concentration (non-cosmetic) — download in pdf [712 KB] or download in word [585 KB]
- High volume lower hazard (non-cosmetic) — download in pdf [724 KB] or download in word [595 KB]
- High molecular weight polymer (non-cosmetic) — download in pdf [734 KB] or download in word [600 KB]

Cosmetics case studies

- Very low volume, no hazard information available (cosmetic) — download in pdf [715 KB] or download in word [585 KB]
- Low concentration (cosmetic) — download in pdf [716 KB] or download in word [590 KB]
- High volume surfactant (cosmetic) — download in pdf [511 KB] or download in word [407 KB]

Step by step 'how to' categorise chemicals under the new scheme

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Remember, you can provide feedback on the draft Guidelines and Rules. It is under consultation until 31 May 2018.

NICNAS, 17 May 2018

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

Medicine labels: Guidance on TGO 91 and TGO 92

2018-05-18

The Therapeutic Goods Administration (TGA) has published 2 guidance documents on medicine labels - TGO 91 and TGO 92. This guidance is to help sponsors and manufacturers of medicines meet the Australian labelling requirements described in the new labelling Orders. There are different risks and information requirements associated with medicines prescribed by a medical practitioner (or used in a clinical setting) to those self-selected by consumers. As a result, the labels for these two types of medicines need to reflect the different contexts in which they're used. In recognition of this, medicine label requirements are specified in two separate labelling Orders:

- Therapeutic Goods Order No. 91 - Standard for labels of prescription and related medicines (TGO 91)
- Therapeutic Goods Order No. 92 - Standard for labels of non-prescription medicines (TGO 92)

In addition to the Orders, other Australian legislation applies to medicine labels. For example, State or Territory legislation for medicines and poisons, and Commonwealth advertising requirements for therapeutic goods.

Transition period

A four-year transition period has been provided for the implementation of TGO 91 and 92 which, together, will eventually replace Therapeutic Goods Order No. 69 - General requirements for labels for medicines (TGO 69).

Specific transition period provisions are described in section 4 of the Orders. During this time, medicines must comply with either TGO 69 or TGO 91/TGO 92 (whichever is relevant). Medicines that are released for supply on or after 1 September 2020 (the end of the transition period) must comply with either TGO 91 or TGO 92, whichever is relevant. In 2017 TGO 69 was remade so that it remains in force during the 4-year transition period.

How to use the guidance

The Therapeutic Goods Administration (TGA) has published 2 guidance documents on medicine labels - TGO 91 and TGO 92.

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This guidance is not provided as a legal interpretation of TGO 91 or TGO 92. It includes clarification on, and information relating to, the mandatory requirements. It also includes additional information outlining best practice recommendations for medicine labels. Where the words 'must' or 'required' are used, a legal requirement is being described.

Structure of the guidance

This guidance is divided into four parts.

Part 1 describes the structure of the Orders and legal requirements that generally apply to all medicines.

Part 2 provides guidance to assist you to identify the legal mandatory requirements that apply to certain types of medicines. For each type of medicine, there are references to specific relevant sections of the Orders.

Part 3 provides guidance on the design of medicine labels and some 'best practice principles'. This information is not mandatory but is included to further improve the safe and quality use of medicines.

Part 4 provides guidance on the tabulated display of Critical Health Information. This includes both mandatory requirements and best practice guidance.

TGA, 15 May 2018

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

Trade Name Annex report

2018-05-18

In the Chemical Gazette May 2018, the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) confirmed the removal of all the products listed in the Trade Name Annex (TNA) and the addition of 12 industrial chemicals to the non-confidential section of the Inventory. This report outlines our TNA activity including consultation, information received and the background to the TNA. The Australian Inventory of Chemical Substances (the Inventory) according to the *Industrial Chemicals (Notification and Assessment) Act 1989* (the Act) should be a list of individual chemical substances, not products that are a mixture of chemical substances. The TNA of the Inventory was created in 1992 as a temporary measure and included 2526 products listed by trade name and a general product description. NICNAS needed composition information about products listed on the TNA. The agency started a consultation

In the Chemical Gazette May 2018, the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) confirmed the removal of all the products listed in the Trade Name Annex (TNA) and the addition of 12 industrial chemicals to the non-confidential section of the Inventory.

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process with industry associations in late 2016 about the best way to get this information. Following this consultation, a notice was published requesting composition information on the products listed on the TNA from any Australian entity. Industry were given 12 months to submit the information, with a closing date of 9 March 2018. Businesses were given the choice of providing information on the composition of the products in the TNA online or in writing. As well as the Gazette Notice, NICNAS emailed business registrants to advise them of the TNA notice. In addition, 3 reminder Gazette notices were published. By the March 2018 deadline:

- 23 companies provided composition information on 88 TNA listed products;
- Of all the chemicals reported, 12 chemicals were not on the Inventory;
- There were no confidential listing applications;
- After the March 2018 deadline, all TNA products were removed and the 12 chemicals not already on the Inventory were added.

Outcomes of the TNA activity

During the 12-month consultation period from March 2017 to March 2018:

- NICNAS received 161 enquiries via email and about 40 enquiries by phone.
- Out of the 2526 products on the TNA, information was reported for 131 products.
- 23 companies submitted composition information on 88 products on the TNA totalling 807 chemicals. However, some of these chemicals were reported multiple times in different products. Two hundred and seventy-five (275) unique chemicals were reported.
- Table 1 indicates the total number of TNA products' composition information received.
- 3 companies identified 43 TNA products that were obsolete or no longer in production or being marketed in Australia. They confirmed that all substances contained in the products were listed on the Inventory. No composition information was provided for these products.
- 12 of the 275 chemicals submitted were not on the Inventory and were added under section 20AB of the Act. NICNAS conducted a preliminary search of databases to identify if any of the 12 chemicals were hazardous. 4 of the 12 chemicals were considered hazardous, 4 chemicals were not listed in ECHA C&L Inventory database and

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no hazard classification could be identified from other sources for 4 chemicals.

- A list of chemicals that were not listed in the Inventory including information on hazard classification and labelling is given in Table 2.
- In addition, 3 of the 275 chemicals were not listed on the Inventory:
- 2 of these occur naturally in their unprocessed state and are therefore deemed to be on the Inventory;
- 1 chemical is a hydrate and its anhydrous form is listed on the Inventory. Hydrates need not be listed on the Inventory as the Act regards them as mixtures of water and the anhydrous substance.
- Table 3 shows the chemicals that are considered to be on the Inventory, although not listed on the Inventory.

Table 1 - Number of TNA products with composition information

Number of companies reported products with composition information	Number of products with composition information	Number of unique chemicals reported	Number of chemicals not listed on the Inventory
23	88	275	12

Chemicals added to the Inventory

Table 2 - Chemicals added to the Inventory from TNA activity

CAS Number	CAS Name	Molecular Formula	Hazard classification according to ECHA CLP ¹
68130-31-4	Oxirane, 2-(chloromethyl)-, polymer with alpha-hydro-omega-hydroxypoly[oxy(methyl-1,2-ethanediyl)], 2-propenoate	((C ₃ H ₆ O) _n H ₂ O. C ₃ H ₅ ClO) x.xC ₃ H ₄ O ₂	No information
128819-84-1	1,3-Propanediol, 2-ethyl-2-(hydroxymethyl)-, polymer with 2-(chloromethyl)oxirane, 2-propenoate	(C ₆ H ₁₄ O ₃ . C ₃ H ₅ ClO) x.xC ₃ H ₄ O ₂	Harmful to aquatic life with long lasting effects, causes skin irritation and may cause an allergic skin reaction.

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Table 2 - Chemicals added to the Inventory from TNA activity

CAS Number	CAS Name	Molecular Formula	Hazard classification according to ECHA CLP ¹
26125-61-1	1,4-Benzenedicarbonyl dichloride, polymer with 1,4-benzenediamine	(C ₈ H ₄ Cl ₂ O ₂ .C ₆ H ₈ N ₂) _x	No hazards have been classified.
25765-47-3	1,3-Benzenedicarbonyl dichloride, polymer with 1,3-benzenediamine	(C ₈ H ₄ Cl ₂ O ₂ .C ₆ H ₈ N ₂) _x	No information
121888-68-4	Quaternary ammonium compounds, benzyl(hydrogenated tallow alkyl)dimethyl, stearates, salts with bentonite	C ₁₈ H ₃₆ O ₂ .Na. Unspecified. Unspecified	No hazards have been classified.
214495-33-7	Phenol, 4,4'-(1-methylethylidene) bis-, polymer with N1-(2-aminoethyl)-1,2-ethanediamine, 2-(chloromethyl) oxirane and 2-[[4-(1,1-dimethylethyl)phenoxy]methyl]oxirane	(C ₁₅ H ₁₆ O ₂ .C ₁₃ H ₁₈ O ₂ .C ₄ H ₁₃ N ₃ .C ₃ H ₅ ClO) _x	No information
179796-73-7	1,2-Ethanediamine, N1,N1'-[1,7-heptanediy]bis[[4,5-dihydro-1H-imidazole-2,1-diyl]-2,1-ethanediyl]] bis-	C ₂₁ H ₄₄ N ₈	Harmful if swallowed, causes serious eye irritation, harmful if inhaled, causes skin irritation and may cause an allergic skin reaction.
53563-70-5	Poly(oxy-1,2-ethanediyl), alpha-(carboxymethyl)-omega-(octyloxy)-	(C ₂ H ₄ O) _n C ₁₀ H ₂₀ O ₃	Causes serious eye damage and skin irritation.
2035064-87-8	Siloxanes and Silicones, di-Me, reaction products with chlorotrimethylsilane, iso-Pr alc., silica and sodium silicate	Unspecified	No information

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Table 2 - Chemicals added to the Inventory from TNA activity

CAS Number	CAS Name	Molecular Formula	Hazard classification according to ECHA CLP ¹
121888-67-3	Quaternary ammonium compounds, benzylbis(hydrogenated tallow alkyl)methyl, bis(hydrogenated tallow alkyl) dimethylammonium salts with hectorite	Unspecified. Unspecified. Unspecified	No hazards have been classified.
18765-38-3	Silicic acid (H ₄ SiO ₄), tetrakis(2-butoxyethyl) ester	C ₂₄ H ₅₂ O ₈ Si	Causes serious eye irritation, causes skin irritation and may cause respiratory irritation.
67701-02-4	Fatty acids, C14-18	Unspecified	No hazards have been classified.

¹ According to the classification notified by companies to the European Chemicals Agency (ECHA) under Classification, Labelling and Packaging (CLP) regulations.

Chemicals not listed but considered to be on the Inventory

Table 3 - Chemicals not listed but considered to be on the Inventory

CAS Number	CAS Name	Molecular Formula	Comments
10028-15-6	Ozone	O ₃	Naturally occurring Deemed to be on the Inventory
1318-59-8	Chlorite-group mineral	Unspecified	Naturally occurring Deemed to be on the Inventory

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Table 3 - Chemicals not listed but considered to be on the Inventory

CAS Number	CAS Name	Molecular Formula	Comments
10213-79-3	Silicic acid (H ₂ SiO ₃), disodium salt, pentahydrate	H ₂ O Si ₅ H ₂ O ₂ .2Na	The anhydrous form CAS RN 6834-92-0 "Silicic acid (H ₂ SiO ₃), sodium salt (1:2)" is on the Inventory) Hydrates are not listed on the Inventory as the Act regards them as mixtures of water and the anhydrous substance.

Background to the TNA

The Inventory is a legal device to distinguish existing chemicals from new chemicals. The Inventory lists chemicals by their Chemical Abstracts Service names and numbers (CAS) and molecular formulas. The Inventory was developed over 4 phases from the late 1970s until 1990. In the later stages some companies were unable to get information from their suppliers on the individual ingredients in some products. To complete and publish the Inventory some businesses were allowed to nominate trade names. To be eligible, the business had to show they were unable to get the chemical details for a product from their supplier(s), through no fault of their own. This led to the creation of the TNA, first published in 1992, as volume 2 of the public Inventory. The TNA contained 2526 products listed by their trade names and a general product description. The TNA was to be an interim measure to give nominators time to identify the chemicals in their products. However, companies did not provide the chemical details of products listed on the TNA.

NICNAS, 17 May 2018

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

The United States Department of Labor's Occupational Safety and Health Administration (OSHA) confirmed that it will begin enforcing certain requirements of the final rule on occupational exposure to beryllium in general industry, construction, and shipyards on 11 May 2018.

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OSHA Announces Delayed Enforcement of Certain Provisions of the Beryllium Standard

2018-05-18

The United States Department of Labor's Occupational Safety and Health Administration (OSHA) confirmed that it will begin enforcing certain requirements of the final rule on occupational exposure to beryllium in general industry, construction, and shipyards on 11 May 2018. Those requirements include the permissible exposure limits in the general industry, construction, and shipyard standards; and the exposure assessment, respiratory protection, medical surveillance, and medical removal provisions in the general industry standard. Aside from these requirements, other ancillary provisions included in the beryllium standard for general industry will not be enforced until 25 June 2018. However, under the terms of settlement agreements with petitioners who challenged the rule, the Agency plans to issue a proposal to further extend this compliance date for the ancillary provisions to 12 December 2018. OSHA previously proposed to remove the ancillary requirements from the beryllium standards for the construction and maritime industries. In accordance with that proposal, OSHA will enforce the permissible exposure limits, but will not enforce any other provisions for beryllium exposure in those standards unless it provides notice. Certain compliance dates outlined in the rule remain unchanged. Enforcement of the general industry requirements for change rooms and showers will begin March 11, 2019; and requirements for engineering controls will begin 10 March 2020.

OSHA, 10 May 2018

<http://www.osha.gov>

Hawaii lawmakers pass ban on sunscreen chemicals oxybenzone and octinoxate

2018-05-18

Hawaii's legislature earlier this month passed a bill that would prohibit the sale of sunscreens containing either of two compounds as of 1 January 2021. According to the measure, octinoxate, which is also known as octyl methoxycinnamate, and oxybenzone "have significant harmful impacts on Hawaii's marine environment and residing ecosystems, including coral reefs." Some published studies have linked oxybenzone to deformities in coral larvae and linked both sunscreen chemicals to coral bleaching,

A federal agency plans new limits on a class of toxic chemicals that are stricter than those issued by the Environmental Protection Agency, and which would cause a "public relations nightmare" if they were published without coordination with other agencies, EPA officials have warned.

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a condition in which stressed coral lose symbiotic algae. Hawaii's government in 2016 began asking swimmers, surfers, and divers to avoid using sunscreens with oxybenzone. The Consumer Healthcare Products Association, which represents sunscreen makers, opposes the bill. "There is no scientific evidence that under naturally occurring environmental conditions, sunscreen ingredients are contributing to coral degradation," the group told Hawaii lawmakers last year. Gov. David Ige (D) has not indicated whether he would sign the legislation, which would exempt prescription sunscreens.

Chemical & Engineering News, 11 May 2018

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

White House feared PR 'nightmare' over agency's stricter chemical limits

2018-05-18

A federal agency plans new limits on a class of toxic chemicals that are stricter than those issued by the Environmental Protection Agency, and which would cause a "public relations nightmare" if they were published without coordination with other agencies, EPA officials have warned. Perfluorocarbons (PFCs), whose uses once included non-stick cookware and firefighting foams, have been linked to certain cancers, low birth weight in infants, and immune-system problems. They are not regulated by the federal government but are subject to limits by an increasing number of states, including New Jersey. In Pennsylvania, two of the chemicals have been found at levels exceeding EPA guidelines near Warrington in Montgomery County, where the contamination of public and private water supplies has been blamed on the use of firefighting foams at several military bases. National data on PFC contamination were published in 2017 by Northeastern University and Environmental Working Group (EWG), a non-profit that advocates for stronger regulation of PFCs. Now, internal EPA emails show that the federal Agency for Toxic Substances and Disease Control is planning to publish recommendations that EPA officials warned would fuel public alarm over whether people are being exposed to hazardous levels of the chemicals through drinking water and food. The emails were first published on May 11 by Inside EPA, an independent newsletter that covers the agency, and is seen by the scientific community as an authoritative source. The ATSDR's recommended limit for one of the chemicals, PFOS, is 10 times lower than the EPA's health advisory level, EPA official Richard Yamada said, according to one of the emails. "Seems like they want to roll out and

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do their own thing – estimate they use is 10-fold lower than most – not sure our scientists agree.” For PFOA, another type of PFC, the ATSDR’s recommended limit is one-seventh of the EPA’s health level, according to an estimate by Inside EPA. “The public, media and Congressional reaction to these new numbers is going to be huge,” an unidentified White House official wrote in an email forwarded to an EPA official. The emails were obtained in mid-April by the Union of Concerned Scientists via a Freedom of Information Act request, said Yogin Kothari, a senior Washington representative for the advocacy group. Kothari said the emails and other documents obtained by UCS are now posted on the organization’s website. “The impact to EPA and DoD [the Department of Defence] is going to be extremely painful,” the email said in January. “We (DoD and EPA) cannot seem to get ATSDR to realize the potential public relations nightmare this is going to be.” One of the emails, also in January, said ATSDR was getting ready to publish draft recommendations for minimal risk levels of four types of PFC in the Federal Register in order to take public comment. While the recommended levels varied widely for children and adults, the public will focus on the lowest levels and find locations where those limits are exceeded, it said. U.S. Rep. Brian Fitzpatrick, a Republican who is seeking re-election this year in the First Congressional district under the state’s redrawn electoral map, called on the EPA to respond to claims by advocates including the UCS that the agency is trying to suppress the ATSDR’s recommendations on the chemicals. Fitzpatrick’s district includes the Warrington and Warminster area where PFC contamination has been found. “I am troubled to hear that exposure to these chemicals could be even more dangerous for our sensitive populations than previously thought,” Fitzpatrick said in a statement on Tuesday. “It would be unacceptable if the political considerations of those at the highest levels of the EPA led to the suppression of information concerning the public health of Americans. The EPA must provide my constituents with answers to these allegations immediately.” The EPA responded to Fitzpatrick’s statement by saying that it will seek a “uniform” approach to the chemicals among federal agencies at a summit meeting called by EPA next week. “EPA is eager to participate in and contribute to a coordinated approach so each federal stakeholder, EPA, DOD, and HHS, is fully informed on what the other stakeholders concerns, roles, and expertise can contribute and to ensure that the federal government is responding in a uniform way to our local, state, and Congressional constituents and partners,” the EPA statement said on Tuesday afternoon. The agency earlier said it had contributed to ATSDR’s development of minimal risk levels for the chemicals. EWG said the emails show ATSDR coming under pressure from other government agencies, including

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EPA, which has rolled back many kinds of environmental protection including limits on emissions from power plants and automobiles under Administrator Scott Pruitt. "Unlike Scott Pruitt's Pollution Protection Agency, there is still one government agency clearly trying to safeguard the public from these dangerous chemicals," said EWG President Ken Cook, in a statement. "Only Scott Pruitt and the Trump administration would consider reducing drinking water contamination for the American people to be a 'nightmare.'" EWG said it expects the ATSDR's recommendations on the chemicals will be a prominent and controversial feature of next week's EPA summit. "The ATSDR study will be the elephant in the room," at the meeting, the group said in a statement. The non-profit said EPA has ignored many studies showing that the chemicals are harmful to human health even at very low levels and urged state and local delegates to next week's summit to press EPA on that subject. ATSDR, a branch of the Department of Health and Human Services, confirmed that it is preparing to publish a revised "toxicological profile" of four types of PFCs that will include provisional minimum risk levels (MRLs) for the chemicals. An MRL is an estimate of daily human exposure to a chemical that is likely to be without appreciable adverse noncancerous health effects over a specified time period. Responding to questions from StateImpact, the agency did not say whether the recommended levels would differ from those of the EPA or when they would be released. "We are working with the EPA, DoD and other federal partners to provide consistent and proper interpretation of the role of MRLs, and how they should be used and interpreted," ATSDR said in a statement. In the emails, one EPA official, Jennifer Orme-Zavaleta, said there wasn't a significant difference between EPA and ATSDR on drinking water. But her colleague Peter Grevatt said there may be "significant concerns, especially considering implications for susceptible populations which came as a surprise." In the last four years, growing concern over PFCs has led New Jersey to begin implementing some of the strictest standards in the nation. The chemicals are no longer used in U.S. manufacturing but they persist in some water supplies and are used in some other countries.

State Impact, 15 May 2015

<https://stateimpact.npr.org>

A top European Union court has upheld the ban on three insecticides blamed for killing off bee populations, dismissing cases brought by chemicals giants Bayer and Syngenta.

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EU court upholds curbs on bee-killing pesticide

2018-05-18

On 17 May 2018, a top European Union court upheld the ban on three insecticides blamed for killing off bee populations, dismissing cases brought by chemicals giants Bayer and Syngenta. "The General Court confirms the validity of the restrictions introduced at EU level in 2013 against the insecticides clothianidin, thiamethoxam and imidacloprid because of the risks those substances pose to bees," a court statement said. "Given the existence of new studies (...) the Commission was fully entitled to find that it was appropriate to review the approval of the substances in question," it specified. Bees help pollinate 90 percent of the world's major crops, but in recent years have been dying off from "colony collapse disorder," a mysterious scourge blamed partly on pesticides. The three pesticides are based on the chemical structure of nicotine and attack the nervous systems of insect pests. Past studies have found neonicotinoids can cause bees to become disorientated such that they cannot find their way back to the hive and lower their resistance to disease. Fears have been growing globally in recent years over the health of bees. Pesticides have been blamed as a cause of colony collapse disorder along with mites, pesticides, virus and fungus, or some combination of these factors. Vytenis Andriukaitis, EU Commissioner for Health and Food Safety, tweeted that he welcomed the decision of the European Court of Justice. "We respect the verdict of the Court in all cases, even if we find it particularly unfortunate that in 2 of the 3 cases the Court decided to dismiss. There may be a cognitive ease to blaming pesticides for affecting bee health, but experts, including the Commission itself, have acknowledged that it can be influenced by multiple and complex factors," Graeme Taylor from the European Crop Protection Association (ECPA) told Euractiv. "We will continue our efforts as an industry to strengthen biodiversity and ensure honey bees and other pollinators can continue to play a vital role in agriculture," he said. Greenpeace EU food policy adviser Franziska Achterberg said the ruling "sets the EU's priorities straight – its primary duty is to protect people and nature, not company profit margins". "It's an indictment against corporate bullying that should spur the Commission to act on other dangerous pesticides without fear of being challenged in court," she said in a statement. The European Commission decided on 27 April to impose a complete ban on neonicotinoids, after managing to achieve the necessary qualified majority among EU member states. 18-member states, including France, Germany,

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Italy and the UK, have endorsed a Commission proposal to further restrict the use of three active substances used in pesticides (Bayer's imidacloprid and clothianidin, and Syngenta's thiamethoxam). The countries that voted against were Hungary, Romania, Denmark and the Czech Republic, EURACTIV was informed. Declining numbers of bees, butterflies and midges could leave companies facing the prospect of reduced crop quality and a shortage of raw materials. A United Nations-backed study found that most businesses surveyed were unsure of what action to take. The Commission's proposal was based on a scientific assessment by the European Food Safety Authority (EFSA), which recently re-confirmed that neonicotinoids pose a risk to bees. In an assessment published on 28 February, the EU food safety watchdog re-assessed data from 2013 of the three neonicotinoids, clothianidin, imidacloprid and thiamethoxam. Its main conclusion was that most uses of neonicotinoid pesticides represent a risk to wild bees and honeybees. "There is variability in the conclusions, due to factors such as the bee species, the intended use of the pesticide and the route of exposure. Some low risks have been identified, but overall the risk to the three types of bees we have assessed is confirmed," said Jose Tarazona, head of EFSA's Pesticides Unit. Commenting on the risks found in the report, an EFSA spokesperson told EURACTIV at the time of the new assessment's release that bees could be exposed to neonicotinoids in multiple ways, depending on the use of the pesticide. "The conclusions on risk reported in the reviews varied according to factors such as the bee species, the intended use of the pesticide and the route of exposure (residues in bee pollen and nectar; dust drift during the sowing/application of the treated seeds; and water consumption)," the EFSA official said. "However, taken as a whole, the conclusions confirm that neonicotinoids pose a risk to bees."

Euractiv, 17 May 2018

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

Plant protection products Regulation list of approved active substances updated

2018-05-18

The following substance has been added to the list of approved active substances under the Plant protection products Regulation (EC) No. 1107/2009 as per Commission Implementing Regulation (EU) 2018/691 of 7 May 2018:

- Talc E553B

New substances have been added to the approved Plant Protection Products Regulation list.

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The approval of the following active substances under the Plant protection products Regulation (EC) No. 1107/2009 has been renewed as per Commission Implementing Regulation (EU) 2018/679 of 3 May 2018 and Commission Implementing Regulation (EU) 2018/692 of 7 May 2018:

- Forchlorfenuron
- Zoxamide

The specific provisions relating to conditions of approval of the following active substance under the Plant protection products Regulation (EC) No. 1107/2009 have been updated as per Commission Implementing Regulation (EU) 2018/690 of 7 May 2018:

- Fenazaquin

As a result, these substances have now been updated in the list of approved active substances (the Annex to Commission Implementing Regulation (EU) No. 540/2011).

Chemtrac, 15 May 2018

<https://www.chemtracglobal.com/news>

Switzerland to vote on pesticide ban 'in 3 years'

2018-05-18

Swiss citizens will get the chance to vote on a complete ban on the use of synthetic pesticides after campaigners secured enough signatures to force a referendum. More than 100,000 Swiss signed the call for a ban that would apply to all farmers, industries and imported foods. If the vote is passed, Switzerland would become only the second country after Bhutan to implement a full ban. But it could be at least three years before voters go to the poll. Over the past 12 months, the future use of pesticides has been a hotly debated topic across Europe. After months of deadlock, the EU re-approved the widely used weedkiller, glyphosate, for five years. France though says it aims to ban the chemical in the country within three years. Just a few weeks ago, the EU agreed a near total ban on the use of neonicotinoids, the most widely used class of insecticides in the world. The Swiss initiative would go much further than the handful of towns and regions around the world that have already banned all synthetic pesticides. It would also be of greater global significance than the ban imposed by Bhutan in 2013, as Switzerland is the home of the world's biggest pesticide manufacturer, Syngenta. The formal petition will be presented to the Federal Chancellery in Bern on 25 May. "At the beginning it started rather slowly, but then it gathered a lot of support especially

Regulatory Update

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from young people and then it gathered momentum and, in the end, we had plenty of signatures," said Antoinette Gilson who's with a group of Swiss citizens called future3 that are pushing for the ban. The details of the signatures will be checked and transferred to the Federal Council, which is the Swiss federal cabinet. They have one year to give recommendations to parliament. The legislators then have two further years to accept the initiative and schedule a vote, or to come up with a counter initiative that could also feature on the ballot. If passed, all synthetic pesticides would be phased out over a period of 10 years. "To not use any pesticides will trigger a complete change in agricultural practices," said Antoinette Gilson. "It might be difficult to go through, but in Switzerland already around 13% of farmers are organic. I talk to a lot of them and I have not met one who has regretted giving up pesticides." The rules would also apply to imports which could have significant impacts on neighbouring countries as Switzerland imports almost 500kg of food per head of population, according to figures from the Federal Customs Administration. Farmers and industry representatives are dismissive of the idea of the referendum, saying that it is too extreme and will not gain popular support. "The initiative is too radical and overshoots the goal," said Anna Bozzi from Science Industries Switzerland in a statement. "Plant protection products are indispensable to ward off diseases and pests. A general ban would affect tremendously the yields as well as the quality of the agricultural products in Switzerland. The import ban would thwart supply and drive up prices." Supporters of the initiative think that if the Switzerland vote is eventually carried, it will have knock-on effects for others. "I am convinced that other countries may follow suit," said Prof Edward Mitchell from the University of Neuchâtel. "Switzerland with its direct democracy system is somewhat different from other countries, making such a change perhaps more likely in the short term. "This puts us in a privileged position to act proactively rather than in response to government actions, and with this goes a responsibility to do so." "This is my personal opinion and it is likely that many Swiss citizens also think this."

BBC News, 16 May 2018

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

REACH Update

CHEMWATCH

More information on biocidal products to be available in 2018

2018-05-17

Summaries of product characteristics and non-confidential assessment reports will be available on the European Chemicals Agency's (ECHA) website by the end of 2018. ECHA will make more information on biocidal products available on its website. There will also be more options for users to search for information, and it will be possible to compare products.

What will be published?

- Non-confidential assessment reports by national authorities;
- Updates to the authorisation status of products (amendments, revisions and renewals);
- Summaries of product characteristics, containing key product information, including:
 - product trade names;
 - substances in the product and their concentrations;
 - biocidal product composition;
 - the manufacturer of the product;
 - the manufacturer of the active substance;
 - hazard and precautionary statements;
 - the organism the product is targeted at;
 - application methods;
 - type of packaging; and
 - instructions for use.

What will remain confidential?

Information that can undermine the protection of the commercial interests or the privacy of the persons concerned. This includes details of the full composition of the product and the precise tonnage of the active substance or product manufactured or made available on the market. The function of a non-active substance in a biocidal product can be considered confidential. The name of a non-active substance can also be considered confidential unless being aware of its existence is essential for the proper use of the product or the substance is of concern.

Next steps

Summaries of product characteristics and non-confidential assessment reports will be available on the European Chemicals Agency's (ECHA) website by the end of 2018.

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To make sure the information will be correctly published, the Member State competent authorities for biocidal products are checking the assessment reports, summaries of product characteristics and decisions available in R4BP 3, the biocides IT tool. Before uploading an assessment report, they will contact the relevant companies directly to check what information should be kept confidential. The work is planned to be finalised by the end of November 2018. Further information is available at:

- [Information on biocidal active substances and products](#)
- [Understanding the Biocidal Products Regulation](#)
- [Guidance on the Biocidal Products Regulation](#)
- [Member State competent authorities](#)

ECHA, 16 May 2018

<http://echa.europa.eu>

2 substances notified to the RoI for CLH proposals

2018-05-17

On 16 May 2018, the following substances were notified to the Registry of Intentions for Harmonised Classification and Labelling (CLH) proposals:

- Desmedipham
- Phenmedipham

This brought the number of current CLH intentions to 51.

Chemtrac, 16 May 2018

<https://www.chemtracglobal.com/news>

Payment of REACH registration fees: Include the invoice number and make only one payment per invoice

2018-05-17

When paying your REACH registration fee, indicate the invoice number in the reference or free text field of your payment. This will allow REACH-IT to automatically identify your payment and confirm that your registration fee has been paid. Also, to avoid any delays in the processing of your registration, make only one payment per invoice. Indicating the invoice number (and only the invoice number) in your payment reference is very important – without it REACH-IT will not be able to allocate your payment to your invoice. If the invoice number is missing, ECHA will need to contact you in writing and confirm the receipt of your payment manually in

When paying your REACH registration fee, indicate the invoice number in the reference or free text field of your payment.

REACH Update

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REACH-IT. Only then can the Agency confirm the financial completeness of your registration. This can delay the registration process. In the worst-case scenario, if the relevant invoice number for your payment is not confirmed to ECHA, your registration will be rejected. For REACH-IT to identify your payment, it is also important that you make only one payment per invoice. Remember also that if you do not pay your full registration fee by the invoice deadline, your dossier will be rejected and you will need to make a new submission. In the case of rejections, ECHA cannot refund any fees paid. For more information, have a look at our Q&A on how to pay ECHA's invoice, and share the instructions with your accounting office or the person responsible for payments in your company.

- [How do I pay ECHA's invoice?](#)
- [REACH Fee Regulation \(Article 17\)](#)
- [From submission to decision](#)
- [REACH 2018 web pages](#)

ECHA, 11 May 2018

<http://echa.europa.eu>

RAC opinions issued for 7 CLH proposals

2018-05-17

On 15 May 2018, the Committee for Risk Assessment (RAC) issued opinions on the proposals for Harmonised Classification and Labelling (CLH). The following substances had opinions issued:

- Octamethylcyclotetrasiloxane
- Diisooctyl phthalate
- L-(+)-lactic acid
- Branched hexatriacontane
- Ethofumesate
- [2,4-dioxo-(2-propyn-1-yl)imidazolidin-3-yl]methyl(1R)-trans-chrysanthemate
- 2-[(4-chlorophenyl)methyl]-5-(propan-2-yl)-1-(1H-1,2,4-triazol-1-ylmethyl)cyclopentan-1-ol

Chemtrac, 15 May 2018

<https://www.chemtracglobal.com/news>

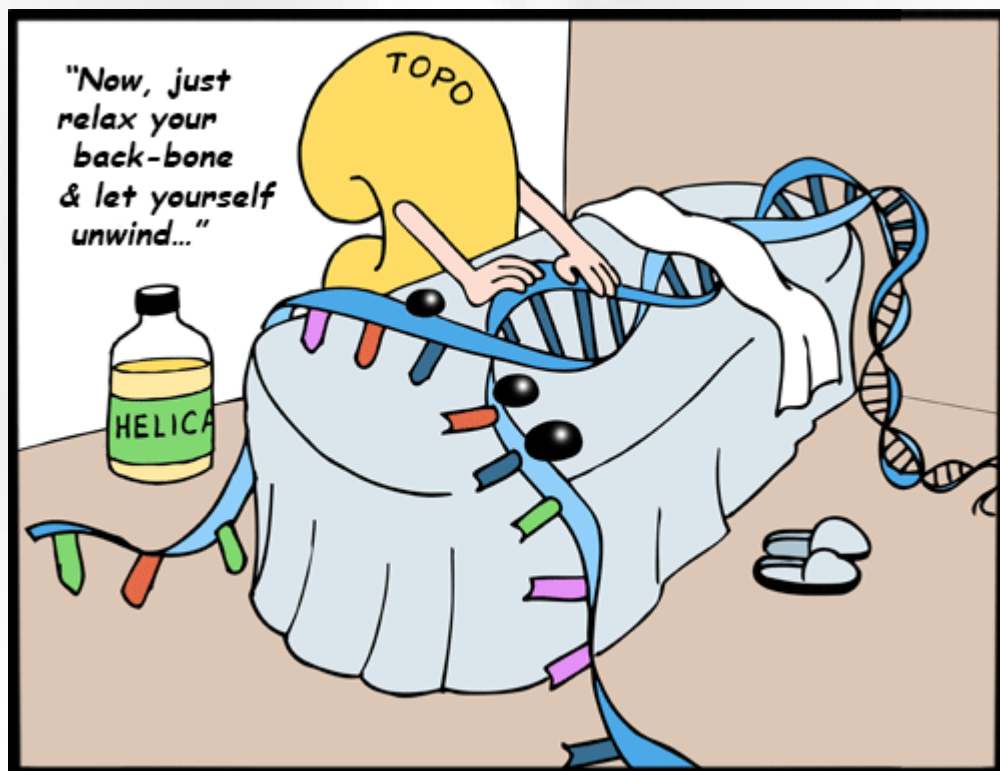
On 15 May 2018, the Committee for Risk Assessment (RAC) issued opinions on the proposals for Harmonised Classification and Labelling (CLH).

Janet's Corner

CHEMWATCH

Just Relax!

2018-05-17



Pinterest

<https://www.pinterest.com.au>

Hazard Alert

CHEMWATCH

Acetone

2018-05-07

Acetone (also known as propanone, dimethyl ketone, 2-propanone, propan-2-one and β -ketopropane) is a common industrial solvent and the simplest representative of the ketone group of solvents with the molecular formula CH_3COCH_3 . A colourless, flammable liquid at room temperature, it occurs naturally and is also chemically synthesised. Acetone is miscible with water, ethanol, and ether and itself serves as an important solvent. [1]

It can polymerise rapidly due to heating and under the influence of air, light and on contact with a catalyst, strong oxidisers and metals such as copper and aluminium, with fire or explosion hazard. As a gas mixed with air, acetone is a fire and explosion hazard. On standing, acetone can form peroxides, which may then explode. Acetone will react with iron and steel in the presence of moisture. It is also capable of dissolving plastic glasses frames, jewellery, pens and pencils, rayon stockings and other rayon garments. [2]

Acetone is also produced and disposed of in the human body through normal metabolic processes. It is normally present in blood and urine. People with diabetes produce it in larger amounts. [3]

USES [2]

Acetone is used as a solvent for fats, oils, waxes, resins, rubber, plastics, lacquers, varnishes and rubber cements. It is used to make many chemical compounds, rayon, photographic films, plastics, fibres, drugs and other chemicals, for storing acetylene gas, and is present in paint and varnish removers, purifying paraffin and for hardening and dehydrating tissues.

IN THE ENVIRONMENT [4]

A large percentage (97%) of the acetone released during its manufacture or use goes into the air. In air, about one-half of the total amount breaks down from sunlight or other chemicals every 22 days. It moves from the atmosphere into the water and soil by rain and snow. It also moves quickly from soil and water back to air. Acetone doesn't bind to soil or build up in animals. Microorganisms in soil and water break it down. Acetone can move into groundwater from spills or landfills. It is broken down in water and soil, but the time required for this to happen varies.

Acetone (also known as propanone, dimethyl ketone, 2-propanone, propan-2-one and β -ketopropane) is a common industrial solvent and the simplest representative of the ketone group of solvents with the molecular formula CH_3COCH_3 .

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SOURCES & ROUTES OF EXPOSURE [2,4]

Sources of Exposure

- Industry sources: Acetone is produced as a result of manufacturing basic chemicals, plastic products, non-ferrous metals, iron and steel, fabricated metal products, motor vehicles and motor vehicle parts, photographic and scientific equipment, wood products, ceramic products, cement, lime, plaster and concrete products, meat and meat products, rubber products, paper, paper products and industrial machinery. In addition, it is emitted from printing processes, mineral, metal and chemical wholesaling, water supply, sewerage and drainage services and coal mining.
- Diffuse sources: Solid fuels burning for heating in the home and for barbeques and incinerators are thought to be the highest sources of emissions of acetone. It is also present in solvents and aerosols used in the home. Acetone is present in tobacco smoke and landfill sites and is emitted as a result of using lawnmowers.
- Natural sources: Acetone occurs naturally in plants, trees, volcanic gases, forest fires and as a product of the breakdown of body fat.
- Transport sources: Acetone is present in the vehicle exhaust of cars, aeroplanes and from railway operations.
- Consumer products: Acetone is a common ingredient in domestic products. It is found in aerosol paints, architectural coatings, automotive and machinery paints and primers, furniture polish and cleaners, household hard surface cleaners, laundry pre-soaks, pet flea and tick removers, cockroach treatments, laundry starches, lubricating greases and oils, nail enamel and polish and polish remover, particleboard, paints (including interior clear finishes, undercoats and primers), varnish, paint and varnish removers and thinners, liniments for veterinary preparations, pharmaceutical preparations, pre-moistened towelettes, shoe polish, sun tan lotions and oils, and in wood office furniture.

Routes of Exposure

Exposure to acetone occurs via:

- Breathing low background levels in the environment.
- Breathing higher levels of contaminated air in the workplace or from using products that contain acetone (for example, household chemicals, nail polish, and paint).
- Drinking water or eating food-containing acetone.

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- Touching products containing acetone.
- For children, eating soil at landfills or hazardous waste sites that contain acetone.
- Smoking or breathing second hand smoke.

HEALTH EFFECTS [4]

Acute Effects

Upon exposure to acetone, it enters your bloodstream where it is carried to all the organs of the body. If it is a small amount, the liver breaks it down to chemicals that are not harmful and uses these chemicals to make energy for normal body functions. Breathing moderate- to-high levels of acetone for short periods of time, however, can cause nose, throat, lung, and eye irritation; headaches; light-headedness; confusion; increased pulse rate; effects on blood; nausea; vomiting; unconsciousness and possibly coma; and shortening of the menstrual cycle in women. Swallowing very high levels of acetone can result in unconsciousness and damage to the skin in your mouth. Skin contact can result in irritation and damage to your skin. The smell and respiratory irritation or burning eyes that occur from moderate levels are excellent warning signs that can help you avoid breathing damaging levels of acetone.

Chronic Effects

Health effects from long-term exposures are known mostly from animal studies. Kidney, liver, and nerve damage, increased birth defects, and lowered ability to reproduce (males only) occurred in animals exposed long-term. It is not known if the same effects would occur in humans.

Carcinogenicity

The Department of Health and Human Services, the International Agency for Research on Cancer, and the Environmental Protection Agency (EPA) have not classified acetone for carcinogenicity. Acetone does not cause skin cancer in animals when applied to the skin. It is unknown if breathing or swallowing acetone for long periods will cause cancer. Studies of workers exposed to it found no significant risk of death from cancer.

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SAFETY [5]

First Aid Measures

- Eye Contact: Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Get medical attention.
- Skin Contact: In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.
- Serious Skin Contact: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.
- Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.
- Serious Inhalation: Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.
- Ingestion: Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Fire & Explosion Information

- Acetone is flammable
- Auto-ignition temperature is 465°C (869°F)
- Flash Points: closed cup -20°C and open cup -9°C
- Acetone is highly flammable in presence of open flames and sparks, of heat.
- Acetone is soluble or dispersed in water.
- Dry chemical powder should be used to extinguish small fires
- Alcohol foam, water spray or fog should be used to extinguish large fires
- Vapour may travel considerable distance to source of ignition and flash back.
- Acetone forms explosive mixtures with hydrogen peroxide, acetic acid, nitric acid, nitric acid + sulfuric acid, chromic anhydride, chromyl

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chloride, nitrosyl chloride, hexachloromelamine, nitrosyl perchlorate, nityl perchlorate, permonosulfuric acid, thiodiglycol + hydrogen peroxide, potassium ter-butoxide, sulfur dichloride, 1-methyl-1,3-butadiene, bromoform, carbon, air, chloroform, thitriazylperchlorate

Handling & Storage

Keep away from incompatibles such as oxidising agents, reducing agents, acids, alkalis. Store in a segregated and approved area (flammables area). Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Keep away from direct sunlight and heat and avoid all possible sources of ignition (spark or flame).

Exposure Controls & Personal Protection

Exposure Controls

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

Personal Protective Equipment

The recommended personal protective equipments is as follows:

- Splash goggles
- Lab coat
- Vapour respirator (be sure to use an approved/certified respirator or equivalent)
- Gloves

Personal Protection in Case of a Large Spill:

- Splash goggles
- Full suit
- Vapour respirator
- Boots
- Gloves
- A self-contained breathing apparatus should be used to avoid inhalation of the product.

Note: Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

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REGULATION [2,4,5,6]

United States

OSHA: The Occupational Safety and Health Administration (OSHA) has set a maximum concentration limit in workplace air of 1,000 ppm or 2400 mg/m³ for an 8-hour workday over a 40-hour week to protect workers.

NIOSH: The National Institute for Occupational Safety and Health (NIOSH) recommends an exposure limit of 250 ppm or 590 mg/m³ in workplace air for up to a 10-hour workday over a 40-hour workweek.

Australia

Safe Work Australia: Safe Work Australia have set the following exposure limits for acetone:

- Eight-hour Time Weighted Average (TWA) of 500ppm or 1185 mg/m³
- A 15-minute short-term exposure limit (STEL) of 2375 milligrams per cubic metre of air is recommended.

United Kingdom

- TWA: 750 STEL: 1500 (ppm)
- TWA: 1810 STEL: 3620 (mg/m³)

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2. <http://www.npi.gov.au/substances/acetone/index.html>
3. <http://en.wikipedia.org/wiki/Acetone>
4. <http://www.atsdr.cdc.gov/toxfaqs/tfacts21.pdf>
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6. <http://www.cdc.gov/niosh/npg/npgd0004.html>

Gossip

CHEMWATCH

Nanowires could make lithium ion batteries safer

2018-05-08

From cell phones and laptops to electric vehicles, lithium-ion batteries are the power source that fuels everyday life. But in recent years, they have also drawn attention for catching fire. In an effort to develop a safer battery, scientists report in the ACS journal Nano Letters that the addition of nanowires can not only enhance the battery's fire-resistant capabilities, but also its other properties. In lithium-ion batteries (LIBs), lithium ions move back and forth between electrodes through an electrolyte. Traditional LIBs have a liquid electrolyte made of salts and organic solvents, but it evaporates easily and can be a fire hazard. So, researchers have turned their attention to solid-state electrolytes as potential alternatives. Several options have been proposed for solid-state electrolytes, but most are not stable or cannot meet large-scale demands. Polymer electrolytes have shown potential because they are stable, inexpensive and flexible; but they have poor conductivity and mechanical properties. So, scientists have been adding an array of compounds to enhance the electrolyte. Xinyong Tao and colleagues previously made magnesium borate ($Mg_2B_2O_5$) nanowires, which had good mechanical properties and conductivity. They wanted to see whether these properties would also be imparted to batteries when these nanowires were added to a solid-state polymer electrolyte. The team mixed the solid-state electrolyte with 5, 10, 15 and 20 weight percent of the $Mg_2B_2O_5$ nanowires. They observed that the nanowires increased the conductivity of the electrolytes and allowed them to sustain more stress compared to the electrolyte without nanowires. The increase in conductivity was due to an increase in the number of ions moving through the electrolyte at a faster rate. The group also tested the flammability of the electrolyte and found that it barely burned. When the nanowire-enhanced electrolyte was paired with a cathode and anode like it would be in a battery, the set-up had a better rate performance and higher cyclic capacity than batteries without added nanowires.

EurekaAlert, 25 April 2018

<http://www.eurekaalert.org>

Army researcher uses math to uncover new chemistry

2018-05-08

In the future, materials scientists will use advanced software to specify the properties they desire and a program will deliver a choice of optimised

Xinyong Tao and colleagues previously made magnesium borate ($Mg_2B_2O_5$) nanowires, which had good mechanical properties and conductivity. They wanted to see whether these properties would also be imparted to batteries when these nanowires were added to a solid-state polymer electrolyte.

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chemical compounds. Dr. B. Christopher Rinderspacher, a theoretical chemist with the U.S. Army Research Laboratory, recently published a paper describing the process of using mathematics to design chemical compounds by reducing complexity and taking advantage of machine learning. "What this does is actually open up the potential number of compounds," Rinderspacher said. The search for chemical compounds with particularly useful properties is like finding a needle in a haystack, he said. In the past, chemists would search based on an established framework and often find new combinations in a hit or miss fashion. "The problem with that is you never find anything that's truly new or surprising because what we want is something that breaks the norm," he said. "If we stay within our own thought patterns -- conventional thought patterns -- we're never going to find breakout materials." Advances in materials science will result in stronger, lighter armour or equipment for a Soldier of the future. This aligns with Army modernization priorities that seek long-range precision fires, next generation of combat vehicles, future vertical lift platforms and Soldier lethality. Materials science will play a huge role in realizing the Army of the future, officials said. "Science usually works by walking up to the frontier of what we know and poking around," he said. "Where do we find something new and interesting?" By introducing a new path to discovery, Rinderspacher hopes to point chemists in the right direction using a mathematical approach. Using what's known as nuclear charge distributions, he developed a general theoretical framework for finding chemical compounds he's looking for. The conventional path for discovering new chemical compounds is "long and tedious," he said. "If we were to go wherever we wanted, in terms of all the possible chemicals without any restrictions that aren't inherent to your problem, you would be able to access everything." The key, he said, is coming up with a way to optimise what's known as "probability density functions in chemical space." In the next three to five years, Rinderspacher said he hopes to incorporate machine learning with his algorithms to deliver a solution and narrow the search parameters for new chemical compounds. The *Journal of Mathematical Chemistry*, known for its "original, chemically important mathematical results" using non-routine mathematical methodologies, published Rinderspacher's paper. Rinderspacher has been pursuing this line of research since January 2009. That's when he came to the lab as a post-doctoral fellow after earning his doctorate at the University of Georgia. A self-proclaimed puzzle solver, he said he is driven by finding efficient solutions. "I know that some people are really driven by the application that will be at the end, but to me getting it to work is fascinating enough," he said. "I like to look at the problem and then figure out, 'How many other problems are like that and can be solved the same

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way?" The activity of math is thinking about generalising stuff, organising ideas and showing what does and doesn't work, he said. "The right math will get you there," he said. "It's mathematical thinking -- outside of the box -- that I'm trying to enable." Further information is available at: <https://doi.org/10.1007/s10910-018-0896-3>

EurekAlert, 26 April 2018

<http://www.eurekalert.org>

Thorium-aluminium complex the first with an actinide element to donate electrons when bonding with a metal

2018-05-08

A small team of researchers from the University of California, Lawrence Berkeley National Laboratory and LPCNO, Université de Toulouse, has developed a way to synthesise a thorium-aluminium complex with an actinide element to donate electrons when bonding with a metal. In their paper published in the journal *Chemical Science*, the group explains how they achieved the first-of-its-kind feat. Thorium (Th) is a silver-coloured radioactive metallic element. Like other metals, it is relatively hard, but bendable. It also has a high melting point and is very reactive—when exposed to air, it reacts and turns black. It is also considered to be unstable. It is currently used in certain welding applications and is being considered as a replacement material for uranium in some nuclear reactors. As the researchers note, thorium's position on the periodic table is unique because of the reluctance of its 5f orbitals to engage in bonding, as occurs with other actinides. But it is also different chemically from other Lewis acidic transition metals. In this new effort, the team set out to better understand the electronic structure of thorium by looking specifically at bimetallic complexes with metal-to-metal bonds. As part of that effort, they developed a way to synthesize Th–Al bimetallics using reactions between different materials. The resulting complexes are unique because the thorium atoms wound up in a +3 oxidation state. Notably, just 10 Th(III) complexes have ever been synthesised. To synthesise the new Th(III) the researchers induced reactions between di-tert-butylcyclopentadienyl, supported by a Th(IV) dihalide, with an anionic aluminium hydride salt. The resultant material was then reduced, producing the new Th(III). To stabilise the new material, the researchers mated it with an alanate ligand. To prove that that new material was in fact a Th(III), the researchers studied it using EPR spectroscopy, which revealed

A small team of researchers from the University of California, Lawrence Berkeley National Laboratory and LPCNO, Université de Toulouse, has developed a way to synthesise a thorium-aluminium complex with an actinide element to donate electrons when bonding with a metal.

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the shared electrons between the two atoms. They also conducted DFT calculations to show that the thorium had truly donated an electron to the aluminium. The team suggests that their work may be of use to other chemists looking to use actinides as donors. They note also that their experimental results could prove useful in the future as a way to make other actinides such as plutonium, reducing the need for other stabilisers.

Phys.org, 4 May 2018

<http://phys.org>

Switching element made of Cr₂O₃ may yield smaller, more energy-efficient memory for computers and flash drives

2018-05-08

For years, manufacturers have offered computers with increasing amounts of memory packed into smaller devices. But semiconductor companies can't reduce the size of memory components as quickly as they used to, and current designs are not energy-efficient. Conventional memory devices use transistors and rely on electric fields to store and read out information. An alternative approach being heavily investigated uses magnetic fields to store information. One promising version of magnetic device relies on the magnetoelectric effect which allows an electric field to switch the magnetic properties of the devices. Existing devices, however, tend to require large magnetic and electric fields that are difficult to produce and contain. One potential solution for this problem is a new switching element made from chromia (Cr₂O₃), which, one day, may be used in computer memory and flash drives. "The device has better potential for scaling, so it could be made smaller, and would use less energy once it's suitably refined," said Randall Victora, a researcher at the University of Minnesota and an author on the paper. The researchers report their findings in Applied Physics Letters. Computer memory is composed of switching elements, tiny devices that can switch on and off to store bits of information as ones and zeros. Previous researchers discovered that chromia's magnetoelectric properties means it can be "switched" with only an electric field but switching requires the presence of a static magnetic field. Building on these elements, Victora and Rizvi Ahmed have created a design for a memory device with a heart of chromia that does not require any externally applied magnetic field to operate. Their design surrounds the chromia with magnetic material. This provides an effective magnetic field through quantum mechanical coupling to Cr

A new switching element made from chromia may be used in computer memory and flash drives.

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magnetic moments, while allowing devices to be arranged in a way that blocks stray magnetic fields from affecting nearby devices. An element to read out the state of the device, to determine if it's in one or zero state, is placed on top of the device. This could potentially pack more memory into a smaller space because the interface between the chromia and the magnet is the key to the coupling that makes the device function. As the device shrinks, the greater surface area of the interface relative to its volume improves the operation. This property is an advantage over conventional semiconductors, where increases in surface area as size shrinks lead to greater charge leakage and heat loss. Next, Victora and Ahmed aim to collaborate with colleagues who work with chromia to build and test the device. If successfully fabricated, then the new device could potentially replace dynamic random-access memory in computers. "DRAM is a huge market. It provides the fast memory inside the computer, but the problem is that it leaks a lot of charge, which makes it very energy-inefficient," Victora said. DRAM is also volatile, so information disappears once the power source is interrupted, like when a computer crash erases an unsaved document. This device, as described in the paper, would be non-volatile. However, such a memory device will likely take years to perfect. One significant barrier is the device's heat tolerance. Computers generate a lot of heat, and modelling predicts that the device would stop functioning around 30 degrees Celsius, the equivalent of a hot summer day. Optimizing the chromia, perhaps by doping it with other elements, may improve its functioning and make it more suitable to replace existing memory devices.

Phys.org, 4 May 2018

<http://phys.org>

Chemical octopus catches sneaky cancer clues, trace glycoproteins

2018-05-08

Cancer drops sparse chemical hints of its presence early on, but unfortunately, many of them are in a class of biochemicals that could not be detected thoroughly, until now. Researchers at the Georgia Institute of Technology have engineered a chemical trap that exhaustively catches what are called glycoproteins, including minuscule traces that have previously escaped detection. Glycoproteins are protein molecules bonded with sugar molecules, and they're very common in all living things. Glycoproteins come in myriad varieties and sizes and make up important cell structures like cell receptors. They also wander around our

Researchers at the Georgia Institute of Technology have engineered a chemical trap that exhaustively catches what are called glycoproteins, including minuscule traces that have previously escaped detection.

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bodies in secretions like mucus or hormones. But some glycoproteins are very, very rare and can serve as an early signal, or biomarker, indicating there's something wrong in the body – like cancer. Existing methods to reel in glycoproteins for laboratory examination are relatively new and have had big holes in their nets, so many of these molecules, especially those very rare ones, have tended to slip by.

Cancerous traces

"These tiny traces are critically important for early disease detection," said principal investigator Ronghu Wu, a professor in Georgia Tech's School of Chemistry and Biochemistry. "When cancer is just getting started, aberrant glycoproteins are produced and secreted into body fluids such as blood and urine. Often their abundances are extremely low but catching them is urgent." This new chemical trap, which took Georgia Tech chemists several years to develop and is based on a boronic acid, has proven extremely effective in lab tests including on cultured human cells and mouse tissue samples. "This method is very universal," said first author Haopeng Xiao, a graduate research assistant. "We get over 1,000 glycoproteins in a really small lab sample." In comparison tests with existing methods, the chemical trap, a complex molecular construction reminiscent of an octopus, captured exponentially more glycoproteins, especially more of those trace glycoproteins. Wu, Xiao and Weixuan Chen, a former Georgia Tech postdoctoral researcher, who was also first author of the study, published their results in the journal *Nature Communications*. The research was funded by the National Science Foundation and the National Institutes of Health.

Boronic bangles

For chemistry whizzes, here's a short summary of how the researchers made the octopus. They took a good thing and doubled, then tripled down on it. Those who recall high school chemistry class may still know what boric acid is, as do people who use it to kill roaches. Its chemical structure is an atom of boron bonded with three hydroxyl groups (H_3BO_3). Boronic acids are a family of organic compounds that build on boric acid. There are many members of the boronic acid family, and they tend to bond well with glycoproteins, but their bonds can be less reliable than needed. "Most boronic acids let too many low-abundance glycoproteins get away," Wu said. "They can catch glycoproteins that are in high abundance but not those in low abundance, the ones that tell us more valuable things about cell development or about human disease."

Benzoboroxole octopus

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But the Georgia Tech chemists were able to leverage the strengths of boronic acids to develop a glycoprotein capturing method that works exceptionally well. First, they tested several boronic acid derivatives and found that one called benzoboroxole strongly bound with each sugar component on the glycopeptide. ("Peptide" refers to the basic chemical composition of a protein.) Then they stitched many benzoboroxole molecules together with other components to form a "dendrimer," which refers to the resulting branch- or tentacle-like structure. The finished large molecule resembled an octopus ready to go after those sugar components. In its middle, similarly positioned to an octopus's head, was a magnetic bead, which acted as a kind of handle. Once the dendrimer caught a glycoprotein, the researchers used a magnet to grab the bead and pull out their chemical octopus along with its ensnared glycopeptides (e.g. glycoproteins). "Then we washed the dendrimer off with a low pH solution, and we had the glycoproteins analysed with things like mass spectrometry," Wu said.

Cancer treatments?

The researchers have some ideas about how medical laboratory researchers could make practical use of the new Georgia Tech method to detect odd biomolecules emitted by cancer, such as antigens. For example, the chemical octopus could improve detection of prostate-specific antigens (PSA) in prostate cancer screenings. "PSA is a glycoprotein. Right now, if the level is very high, we know that the patient may have cancer, and if it's very low, we know cancer is not likely," Wu said. "But there is a grey area in between, and this method could lead to much more detailed information in that grey area." The researchers also believe that developers could leverage the chemical invention to produce targeted cancer treatments. Immune cells could be trained to recognize the aberrant glycoproteins, track down their source cancer cells in the body and kill them. The research's potential for science goes far beyond its possible future medical applications. The fields of genomics and proteomics have made great strides. Following in their footsteps, this new molecular trap could advance the study of the rising field of glycoscience.

Phys.org, 7 May 2018

<http://phys.org>

Researchers have used non-traditional techniques to fashion one possible solution -- a powerful 3-D lithium ion battery with a footprint on the order of one hundred grains of salt.

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3-D batteries pack power into tiny footprints

2018-05-08

Batteries might seem like they come in every shape and size that you can imagine. But as electronic devices become tinier and skinnier without reducing their power and energy demands, they challenge engineers to design batteries that can fit into smaller and smaller spaces without compromising on performance. Researchers in the United States have used non-traditional techniques to fashion one possible solution -- a powerful 3D lithium ion battery with a footprint on the order of one hundred grains of salt. Their work appears May 3 in the journal *Joule*. "For small sensors, you need to re-design the battery to be like a skyscraper in New York instead of a ranch house in California," says senior author Bruce Dunn, a professor of materials science and engineering at the University of California, Los Angeles (UCLA). "That's what a 3D battery does, and we can use semiconductor processing and a conformal electrolyte to make one that is compatible with the demands of small internet-connected devices." Even the most innovative two-dimensional batteries are limited in the shapes they can take -- the basic battery takes a slice of anode and a slice of cathode and packs an ion-conducting electrolyte between the two to complete the circuit. On the other hand, there are in principle innumerable ways to craft a 3D anode and a 3D cathode that snap together like puzzle pieces (still necessarily separated by a small amount of electrolyte). The setup chosen by Dunn's group is called a "concentric-tube" design, where an array of evenly spaced anode posts are covered uniformly by a thin layer of a photo-patternable polymer electrolyte and the region between the posts is filled with the cathode material. Despite this apparent simplicity, many researchers have only been able to build half of a 3D battery, creating anodes and cathodes that are stable on their own, but fail when trying to assemble these electrodes into one functional battery. Meanwhile, nearly all of the 3D batteries which have been assembled have not been significantly better than ordinary two-dimensional versions. Dunn and postdoctoral scholars, Janet Hur and Leland Smith, overcame these hurdles by taking methods normally used to make semiconductors and modifying them to carve silicon into a grid of precisely-spaced cylinders that they wanted for the anode. "That's something the battery world just does not do," Dunn says. To complete the battery, they applied thin layers of electrolyte to the silicon structure and poured in a standard lithium-ion cathode material, using the anode as a mould to ensure that the two halves would fit together just right. The resulting battery achieved an energy density of 5.2 milli-watt-hours per square centimetre, among the highest reported for a 3D battery, while occupying a miniscule 0.09

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square centimetre footprint and withstanding 100 cycles of charging and discharging. Dunn cautions that this particular 3D battery has not yet reached its full potential, as he hopes that he and his team can boost its energy density with further tuning of battery components and assembly. "Another challenge with batteries is always the packaging," he adds. "You need to seal them up, keep them small, and make sure they function just as well in the real world as in the glovebox."

Science Daily, 3 May 2018

<http://www.sciencedaily.com>

Wine sleuths seek answers to the mystery of 'smoke taint'

2018-05-08

After the smoke had cleared from the October wildfires that ravaged more than 970 km² in Northern California, Anita Oberholster started getting phone calls. Winemakers had harvested most of the grapes in the Golden State by the time the fires began—90% of the tonnage in Napa Valley had been picked, for instance—but some were still on the vines. And winemakers had questions. Many were familiar with "smoke taint," the decidedly unpleasant, ashy flavour wines can take on after grapevines have been exposed to smoke from wildfires. But the approximately 1,200 wineries in the area of California where the October fires burned had never experienced blazes quite as intense as these, particularly during harvest season, when grapes are most sensitive. The winemakers calling Oberholster wanted advice on how they could determine whether their grapes had been tainted. "The more calls I received regarding advice about what to do, the more I realised how much we still don't know" about how the compounds in smoke affect grapes and the wine made from them, says Oberholster, a wine researcher at the University of California, Davis, who also advises winemakers. Wine chemists in Australia have been studying the issue for more than a decade. But smoke taint hadn't been as high a priority for California because the wildfire problem hadn't affected the wine industry as much there, Oberholster says. What we still don't know about smoke taint is "all that's been on my mind" for the past seven months, says Christopher Carpenter, a winemaker for Jackson Family Wines. Some of the vineyard blocks Carpenter presides over in California ripen later in the season because they're in the mountains rather than the valley and hadn't been harvested before the October fires rolled in. Since the fires, the grapes from those regions have been fermented, and their resulting wine is now aging in barrels. "In about a year and a half I

As wildfires increase in frequency across the globe, researchers hunt the smoke compounds that can seep into vineyards' grapes and taint wine

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have to make blending and bottling decisions,” Carpenter says. One type of wine he makes sells for \$375 per bottle. So, if he’s not 100% confident that the 2017 vintage meets his standards, he won’t damage the label’s reputation by selling it. What’s weighing on Carpenter is that there aren’t yet any analytical tests that can absolutely guarantee him the wine isn’t tainted. “We still don’t know exactly what combination of compounds causes the different characteristics that we call smoke taint,” so analytical tests can’t be conclusive, Oberholster says. “And if you have smoke taint, we don’t have effective methods that can treat the wine and remove smoke taint permanently.” The October 2017 wildfires included four of the 20 most destructive in California history. And climate change models from researchers in the U.S. suggest that future wildfires in parts of Northern California could burn up to 40% more land if carbon dioxide levels in the atmosphere double (Clim. Change 2004, DOI: 10.1023/B:CLIM.0000024667.89579.ed). With that predicted increase and similar estimates from countries like Canada and Australia, more and more researchers—Oberholster included—are joining the effort to find answers.

First encounters

Although Napa and Sonoma, the Northern California counties known for wine making, had never experienced wildfires as intense as the ones in October, popular wine-growing regions in Australia had. Australia has a mostly hot, dry climate, so bushfires are frequent, and often devastating, there. The 2009 Black Saturday bushfires in the south-eastern state of Victoria, for instance, killed about 170 people and caused many more to lose their homes. They also cost the wine industry in the region about \$300 million in lost revenue due to smoke taint and other damage. After one particularly bad set of bushfires near Canberra in 2003, vintners in Australia began reaching out to wine scientists for help with the ashy flavours they were tasting in their wines. Researchers from local universities, the Australian Wine Research Institute, and the Department of Agriculture & Food Western Australia responded then and in the ensuing years as more fires cropped up. Researchers like Kerry Wilkinson. Now a professor of oenology at the University of Adelaide, Wilkinson recalls being invited around 2005 to taste wines made by a vineyard that had been in the path of smoke from a nearby “prescribed” burn. Government agencies like the Department for Environment & Water in South Australia periodically burn vegetation to reduce the fuel available and prevent bushfires from damaging residential areas. The wine that Wilkinson tasted was definitely off. “I remember thinking, ‘It’s not that bad,’ the first one or two sips,” she says. “The winemaker said to keep tasting it. And the more

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that we tasted the wine and moved it around in our mouths, the more the ashy character built up. After about three or four mouthfuls, you realized you really couldn't get through a whole glass without knowing there was something wrong." Winemakers often intentionally introduce smoky flavour into red wines by aging them in oak barrels that have been toasted with flames. This wine was different. Oaked wine, Wilkinson says, has "more of a toasty, smoky character that comes through with coconut and vanilla spice" flavours. With wine tainted by smoke, she says, "it's more of a cold ash, acrid, and medicinal-type character. There's a very clear distinction." So, Wilkinson and others in Australia started studying how fires impart "off" flavours to wines (Aust. J. Grape Wine Res. 2015, DOI: 10.1111/ajgw.12183). By comparing the compounds found in tainted wines with those in untainted wines of the same grape variety, the scientists determined that the tainted vino contained higher concentrations of volatile phenols—nontoxic compounds like guaiacol and 4-methylguaiacol commonly found in wood smoke. Through their experiments, the researchers also learned that the smoky compounds slip into grapevines through the plants' leaves and berries, concentrating mostly in the grape skins. A series of other experiments, in which researchers put tents over grapevines in the field and exposed them to intense smoke during certain stages of the vines' growth cycle, taught the scientists that the plants are most vulnerable to taking up smoke when the grapes begin ripening, closer to harvest time. All these results seemed straightforward: The grapes absorb smoke compounds at certain, sensitive times, and voilà! Smoke taint. But further investigations revealed that the situation was more complicated.

Hot on the trail

When researchers in Australia monitored the wine-making process using smoke-exposed grapes, they noticed that during the early stages of fermentation, the wine tasted okay. By the later stages, though, the flavour of smoke taint began to rear its ashy head. Along with Kristen Kennison (now Brodison) of the Department of Agriculture & Food Western Australia, Wilkinson and others first reported this phenomenon in 2008 (J. Agric. Food Chem., DOI: 10.1021/jf800927e). "We analysed the change in volatile phenol concentrations during fermentation, tracked them every couple of days, and saw they were increasing," Wilkinson remembers. At first, this wasn't surprising because the team was making merlot, a red wine. During fermentation of a red wine, the skins of the grapes stay in contact with the juice to give the wine its colour and body. Wilkinson and her team assumed that the grape skins were releasing their volatile phenols, leading to the observed increases. "But then we pressed the wine

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away from the skins, and we continued to get an increase of phenols in the juice," Wilkinson explains. The scientists concluded that guaiacol and its fellow smoke-derived volatile phenols had somehow been masked in the juice and were slowly revealing themselves during fermentation. The most likely scenario was that these phenols had been bound to some other, larger compounds in the wine that couldn't be readily detected with the gas chromatography/mass spectrometry methods researchers typically use to analyse aroma and flavour molecules. These larger, precursor compounds also would have prevented people from tasting the volatile phenols in the original juice. Enzymes in the fermentation yeast, the scientists thought, must have been cleaving the phenols from these larger, non-volatile compounds, making them not only "visible" to GC/MS but also tasteable once again. So, Wilkinson and other researchers in Australia did some sleuthing to uncover the identity of the precursor compounds. What they found were glycoconjugates: volatile phenols that had been linked to one or more sugars. "Adding sugars to molecules is a common mechanism in plants," says Katja Härtl, a postdoc who studies the biochemistry of fruit-bearing plants like grapevines with Wilfried Schwab at the Technical University of Munich. Plants tack carbohydrates onto molecules in their cells to make the compounds soluble and easier to transport and store. In the case of the volatile phenols from wildfires, the grapevines probably use this mechanism to cope with the foreign compounds, Härtl says. The added carbohydrates enable the plants to transport and sequester the phenols, as well as to block the small molecules' functional groups so they can't react and cause trouble inside the plant cells. Härtl, Schwab, and co-workers recently pinpointed a few of the grapevine enzymes, called glycosyltransferases, capable of tacking a single sugar onto volatile phenols like guaiacol (*J. Agric. Food Chem.* 2017, DOI: 10.1021/acs.jafc.7b01886). Wine scientists have now confirmed the identity of a few of the glycoconjugates in smoke-tainted wine—monosaccharide versions like guaiacyl- β -D-glucopyranoside and disaccharide versions like guaiacyl- β -D-gentiobioside. Armed with that knowledge, researchers might one day design better techniques for removing the offending compounds—both the volatile phenols and glycoconjugates—from tainted wine. Currently, methods that can reduce smoke taint are filtration with fining agents like activated carbon from charcoal or filtration with reverse osmosis. But in most cases, none of these nonspecific methods "remove 100% of the nasties" and leave the desirable compounds alone, says Markus Herderich, research group manager at the Australian Wine Research Institute. Activated carbon non-selectively binds all sorts of organic compounds in the wine, not just the ones from smoke taint, and some of them may be important to the wine's colour

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and desired flavour. Standard versions of reverse osmosis remove small molecules like guaiacol but can leave behind the larger glycoconjugates. If these sugar-linked compounds stick around in wine, studies suggest, enzymes or microbes in a person's saliva can break them down to unleash the smoky volatile phenols. To improve winemakers' options, scientists could design advanced materials to recognize, trap, and remove both the glycoconjugates and volatile phenols from wine. Wilkinson, for instance, says she's examining cyclodextrins and molecularly imprinted polymers for this purpose. Or maybe a fermentation yeast could be genetically engineered to stick extra sugars onto the glycoconjugates, making it more difficult for enzymes to unleash the phenols—and their flavour. But what if there is more to smoke taint than glycoconjugates and volatile phenols? Chemists in British Columbia have evidence that the story doesn't end there.

The plot thickens

Graduate student Matthew Noestheden and professor Wesley Zandberg at the University of British Columbia, Okanagan, began investigating smoke taint a few years ago. Supra Research & Development, a local analytical services firm, approached them to better understand the problem and to design improved smoke taint detection methods that could help winemakers. Supra now funds Noestheden's research through an industrial fellowship. In the valley where UBC Okanagan sits, summers are hot and dry, making the region vulnerable to wildfires. Smoke from fires in Washington state also blows into the area frequently and settles into the valley, blanketing the vineyards there. Zandberg and Noestheden wanted to develop a quick-turnaround analytical test that could detect both the smoke taint phenols and the glycoconjugates, not just in wine but also in potentially tainted grapes while they're still on the vine. Vineyards typically have crop insurance that protects them from things like weather, pests, wildlife damage, and smoke taint. But to claim that insurance money, winemakers need to have proof that their crop is spoiled—before plucking it from the vines. Complicated liquid chromatography/mass spectrometry methods are available to detect glycoconjugates directly, but Adelaide's Wilkinson says many analytical testing companies are not yet set up to use them. Some firms test for the glycoconjugates in grapes and wine indirectly by using either enzymes like β -glucosidases or strong acids to break the volatile phenols and the carbohydrates apart, making the phenols detectable by GC/MS. Still, other companies don't bother with the glycoconjugates, testing for only guaiacol and 4-methylguaiacol not bound to sugars, which they argue are adequate indicators of smoke taint.

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All these services can cost a few hundred dollars to analyse samples of wine and grapes and can take from a couple days to more than a week to return results. Through careful testing with GC/MS and LC/MS techniques, Noestheden and Zandberg designed and fine-tuned an acid digestion method they say breaks down all the glycoconjugates in a sample that contain simple sugars like glucose. They first measure the free volatile phenols in their grape samples and then, after the digestion, the ones that had been bound. Their technique analyses not just guaiacol and 4-methylguaiacol but also other prominent volatile phenols in smoke, including syringol and m-, o-, and p-cresol (J. Agric. Food Chem. 2017, DOI: 10.1021/acs.jafc.7b03225). But the two noticed a few peculiar things when later using their protocol to monitor smoke-exposed grapes during fermentation. One was that even though some of the wines Zandberg and Noestheden made from those grapes tasted tainted, the researchers didn't observe high levels of glycoconjugates, as many studies in Australia had before them (Food Chem. 2018, DOI: 10.1016/j.foodchem.2018.03.097). It's possible that different soils, climates, smoke types, and other factors could explain the differences in findings, Noestheden says. The other peculiar thing was that during fermentation, volatile phenol concentrations increased, as expected. But so did the concentration of glycoconjugates (J. Agric. Food Chem. 2017, DOI: 10.1021/acs.jafc.7b04946). "What we think is happening is that even larger compounds are breaking down as a consequence of fermentation" and leading to the increase in glycoconjugates, Zandberg says. "But we haven't proven anything yet." For wine researchers, the news that an unknown class of compounds may also be involved in smoke taint is exciting, Wilkinson says. But all the twists and turns in what's amounting to a wine detective story can be frustrating for industry, she acknowledges. "We don't have all the answers for them just yet." As Carpenter sits in California fretting over his 2017 wines, he holds out hope that by the time he's ready to bottle, someone will have nailed all the smoke taint culprits and come up with a conclusive analysis method. In particular, the method should be one that the wine industry all agrees on to evaluate the bound forms of the volatile phenols, whatever they may be, he says. "Somebody would make a lot of money with it."

Chemical & Engineering News, 7 May 2018

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

A potential alternative to antibiotics, protein-coated beads block bacteria from binding host cells

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Microbeads to combat infection show promise in burn wound simulations

2018-05-08

Computer simulations of microscopic, protein-coated beads that block bacteria from binding to host cells suggest that the microbeads could help reduce or eliminate bacterial infections in burn wounds. Paul Roberts of the University of Birmingham, U.K., and colleagues present these new findings, funded by the BBSRC, in PLOS Computational Biology. The microbeads were developed several years ago as a potential alternative to antibiotics, which are difficult to innovate quickly enough to keep up with the rapid emergence of bacterial strains that are resistant to existing drugs. The tiny plastic spheres are coated with the same protein used by many bacteria to bind host cells. Thus, they compete with bacteria for binding sites, physically keeping them from attaching to host cells. Previous laboratory research has demonstrated the potential of the microbeads to treat infections in burn wounds in rats. To further explore this potential, Roberts and colleagues developed a mathematical model that simulates microbead treatment of rats with burn wounds infected by *Pseudomonas aeruginosa*, a bacterium that often infects burn wounds in humans. The researchers ran computer simulations for a range of parameter values representing different infection scenarios and microbead treatment strategies. This enabled them to explore which conditions allow for effective microbead treatment and how to refine microbead treatment to maximise its anti-bacterial power. The simulations showed that microbead treatment is unlikely to be effective on its own, but when combined with a technique called debridement, it could significantly reduce or eliminate infection. Debridement is a method of cleansing a burn wound with a cloth and is already used regularly to treat burn wounds in humans. "Our results also suggest that these microbeads could be used to complement traditional antibiotic drugs," Roberts says. "In theory, this would allow us to eliminate bacterial infections more rapidly, reducing the quantity of antibiotics used and hence lessening the chances that bacteria will develop resistance to them." Next, the model results will be tested in laboratory experiments to determine if a combined microbead-debridement treatment is as effective as predicted. Meanwhile, Roberts and colleagues are developing more sophisticated mathematical models in order to explore the best ways to combine microbeads and debridement with traditional antibiotic treatment.

Science Daily, 3 May 2018

<http://www.sciencedaily.com>

Researchers have created new superconductors made of layers of bismuth sulfide and a high entropy rare earth alloy oxyfluoride, containing five different rare earth elements at the same crystallographic site.

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Making new layered superconductors using high entropy alloys

2018-05-09

Researchers from Tokyo Metropolitan University have created new superconductors made of layers of bismuth sulfide (BiS₂) and a high entropy rare earth alloy oxyfluoride, containing five different rare earth (RE) elements at the same crystallographic site. The new material retains superconducting properties over a wider range of lattice parameters than materials without high-entropy-alloy states. Their work promises an exciting new strategy for designing new layered superconductors, a potentially key development in the search for high-temperature superconductors. Superconductors are key to a range of exciting potential applications. For example, zero resistivity promises loss-free power transmission and powerful electromagnets. The challenge has been to discover a material that retains this property at higher temperatures, closer to ambient temperatures. Despite focused work and a number of breakthroughs in recent years, the hunt is still on for effective strategies to create new superconducting materials. One strategy is the use of layered materials with a molecular structure consisting of alternating superconducting layers and "blocking layers" acting as insulating spacers. A team led by Associate Professor Yoshikazu Mizuguchi from the Department of Physics, Tokyo Metropolitan University, has uncovered an important aspect of designing the insulating layer. They were able to combine five different rare earth (RE) elements, lanthanum, cerium, praseodymium, neodymium, and samarium, and create a "high entropy alloy" in the blocking layer. High entropy alloys have attracted considerable attention in recent years for their toughness, resistance to fatigue and ductility, amongst many other notable physical properties. The team's new materials, with different proportions of REs (10-30%), exhibited enhanced superconducting properties; in particular, materials with the same period in their molecular structure exhibited a superconducting transition at higher temperatures when the blocking layer contained a high entropy alloy. They believe that the high entropy alloy helps to stabilize the crystal structure of the superconducting layer. The work's impact is not limited to the new materials they present. Given the existence of a large number of superconducting layers which are compatible with RE oxides, this innovation opens the way for a broad new strategy for engineering new, revolutionary superconducting materials.

Science Daily, 4 May 2018

<http://www.sciencedaily.com>

The critical point of water scarcity has led scientists to look for new and efficient ways to make the most of non-traditional sources, including sea water, brackish water and wastewater.

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Engineered polymer membranes could be new option for water treatment

2018-05-08

The world's freshwater resources are in short supply. According to the United Nations, water scarcity affects an estimated 1.9 billion people and 2.1 billion people live with drinking water services that are not safely managed. The critical point of water scarcity has led scientists to look for new and efficient ways to make the most of non-traditional sources, including sea water, brackish water and wastewater. Polymer membranes, which act as a filter to desalinate and selectively remove contaminants from various water sources, have aided water treatment, but their selectivity remains a significant challenge when it comes to filtering chemical properties -- a potential risk to the environment and human health. Chemical and biomolecular engineers at the University of Notre Dame and Purdue University studied self-assembled block polymer membranes, which allow for both customisable and uniform pore sizes, as a platform for water treatment systems. The study, published in Nature Partner Journals -- Clean Water, determined the platform has the potential to advance water treatment technologies. "Most state-of-the-art membranes for water treatment are designed to let water pass through while filtering contaminants," said William Phillip, associate professor in the Department of Chemical and Biomolecular Engineering at Notre Dame. "This approach limits the ability to remove or recover dissolved species based on their chemical identity. The exciting thing about self-assembled block polymer membranes is that you can engineer the nanostructure and pore wall chemistry of the membrane through the design of the block polymer molecules. This capability has the potential to open up a variety of new separation mechanisms that can isolate species based on chemical identity, which in turn could help to enable decentralised reuse of wastewater." Phillip and the research team focused on block polymer membranes because of their well-defined nanostructures and functionality. They were able to molecularly engineer the chemical properties of the polymer to create large areas of high-performance membrane, reduce pore size and design multifunctional pore wall chemistries for solute-specific separation. The membranes could essentially be customized depending on the water source and treatment needed. Membranes that are more selective and more resilient to certain exposures such as chlorine or boric acid and less prone to collecting unwanted properties -- or fouling -- than current state-of-the-art options could improve treatment in a number of ways. They could reduce the number of filtration passes required for irrigation, control concentrations

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of chlorine into the system to help forestall effects of biofouling and reduce chemical demands for membrane cleaning -- reducing operating costs and environmental impact. The global applications are significant when considering those populations without suitable drinking water and limited resources. Transitioning the technology from the laboratory setting to practice presents its own set of challenges that will need to be addressed in the coming years. However, the researchers are hopeful the transition can be made since several of the techniques used to generate self-assembled block polymers are consistent with current membrane fabrication practices.

Science Daily, 4 May 2018

<http://www.sciencedaily.com>

Can this invasive exotic pest make better materials for industry and medicine?

2018-05-08

Researchers at the National Institute of Standards and Technology (NIST) have combined derivatives of two surplus materials -- wood pulp and dried-up pieces of an invasive exotic pest -- to form a new composite material that is flexible, sustainable, nontoxic and UV light-reflective. The material, described in a new paper published in *Advanced Functional Materials*, could soon be used in a wide variety of applications, including food packaging, biomedical devices, building construction and the design of cars, trucks and boats. The key to this unlikely marriage of wood and pests is a motif called the "Bouligand structure," in which molecules stack up in a twisted shape, similar to tiny spiral staircases. Scientists have learned that the Bouligand structure provides a certain kind of resilience to cracking; the force of an impact is guided by those tiny, nanosized, staircase-like twists and turns through a series of detours. Rather than cracking straight through, the energy of a bump or crash is thus deflected through a kind of tortuous path, leaving the overall material intact and functional. While wood does not have a natural Bouligand structure, it has attracted scientists for decades, in part because there is an ample supply of material left over after the processing of paper and commercial lumber. "The idea of making useful products out of wood pulp has long intrigued a lot of people in many different industries," says Jeff Gilman, who leads the composites project team at NIST. By washing that pulp with acid to remove its lignin and amorphous cellulose, scientists discovered several years ago that they could create a milky solution that ultimately dried to form a new material with a Bouligand structure. The key component of this solution

Tunicates are slimy invasive exotic pests that some people like to eat. Now they may be used to make UV-reflective, flexible construction materials.

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was tiny crystalline rods of cellulose, known as cellulose nanocrystals or nanocellulose. However, on their own, the pulp-derived Bouligand films are brittle and won't hold much weight. The NIST team hypothesized that combining the short wood-derived nanocellulose rods with another natural material with longer crystalline rods would result in something new that would be incredibly strong and flexible. With appropriate additives, this new material could be used to create films that could slow down the diffusion of water and oxygen. "The right product, if developed, could be used in everything from aerospace composites to packaging that would keep food fresh," Gilman said. One option for the new composite material: the carcasses of a dried-up aquatic creature called a tunicate that is considered a pest in some countries and a delicious treat in others. In many parts of Asia, the brown aquatic creatures (*Styela clava*) are often cooked and served in spicy sauces. But without natural predators present to eat them in new environments, their populations begin to grow into super-abundant numbers that eventually clog boat engines and fishing gear, outcompete native fish, reduce healthy plankton populations and foul and ruin productive shellfish beds. Some environmental managers think that finding a way to remove and use them as a resource could serve a beneficial purpose. Harvesting them is one option. Like an oyster, the inside of a tunicate is considered the tasty bit. The outside is usually just thrown away, meaning there could be a ready source for this material in areas where they are often cooked. What specifically intrigued the NIST researchers, however, was the tunicate's inner structure, which was made of very long, highly crystalline nanocellulose. These were different from the shorter crystals found in wood. "Tunicates have stuck out as the gold standard for their physical properties," said Johan Foster from Virginia Tech University, who is one of only a handful of teams working on tunicate harvest and research around the globe. Foster gathered and supplied the tunicates for the NIST project from a dock in Western France, where the animals are considered a nuisance species. Some scientists had assumed that a composite made entirely out of long crystalline tunicate nanocellulose would be incredibly strong and tough. However, by testing dried mixed tunicate/wood composite materials, lead author Bharath Natarajan was able to identify the exact point of greatest toughness. "If you put a little tunicate into the wood pulp composite, it makes it a little stiffer, and it doesn't break as quickly and becomes more flexible," Natarajan said. "Put in 10 percent and it's twice as strong. If your mixture is 30 percent tunicate and 70 percent wood pulp, the resulting composite is 15-20 times tougher. But after that, you really don't see an improvement in strength, and there is a reduction in toughness." Tunicates are plentiful, but remain expensive to process, so knowing exactly how much to add is key

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to scaling up their use in the future, and for keeping any resulting products affordable. Adding the tunicates also caused the nanocrystals to twist in a different way and accelerated the structure formation in the wood pulp. It also formed a pattern that was tighter and denser, making the new composite material UV-reflective. "Many materials begin to degrade if they are exposed to the sun for a long time," said Gilman. "This material could potentially be used as a coating on other surfaces in order to reflect light and extend durability." In the coming years, Natarajan and his team will continue to test ways their new tunicate-wood pulp mixture could be used to manufacture resilient, flexible and UV-reflective composites for use in the manufacture of sustainable, lightweight automobiles and aerospace vehicles, among other products.

Science Daily, 4 May 2018

<http://www.sciencedaily.com>

A Sample of Weapons-Grade Plutonium Is Missing From Idaho, Officials Announce

2018-05-08

Don't freak out, but a very small speck of weapons-grade plutonium has gone missing from Idaho State University. The specimen in question is 1 gram (0.04 ounces) of plutonium-239 - roughly the weight of a paperclip. Plutonium was at the core of the Fat Man bomb that was dropped over Nagasaki in 1945, and it doesn't occur naturally. It can only be made in nuclear reactors, which is why each sample is very carefully documented and controlled to make sure it doesn't get in the wrong hands. Except in this case. According to the Nuclear Regulatory Commission (NRC), the plutonium sample - officially known as AP-237 - was last recorded by the university in 2004 and could have been lost anytime between now and then. It wasn't until October 2017 that anyone formally realised it was missing. Small samples of plutonium are used by the university's researchers to measure radiation exposure. Apparently, staff at the university noticed a loss of integrity in this sample back in 2004, and as a result sealed it up in clearly marked protective covers, and then put it aside to be disposed of. After that, it was deleted from the official database of nuclear materials - but no one ever recorded where it ended up. "Unfortunately, because there was a lack of sufficient historical records to demonstrate the disposal pathway employed in 2003, the source in question had to be listed as missing," Cornelis Van der Schyf, vice president of research at Idaho State, told the Associated Press. Although it's easy to jump to worrying conclusions, the NRC isn't overly concerned. "We

Don't freak out, but a very small speck of weapons-grade plutonium has gone missing from Idaho State University.

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suspect that it ended up in a landfill for radioactive materials,” Dricks told Rafi Letzter over at Live Science. While he couldn’t confirm there was no risk to the public, it seems like this is more a case of bad record keeping, rather than a James Bond-type scenario. The NRC is now asking Idaho State University to pay an US\$8,500 fine. The university also has 13 other gram-sized samples of plutonium, and these will need to be turned over while their protocols are reviewed by the NRC. The good news is that even if this sample did end up in the wrong hands, it’s not enough to make a full nuclear bomb, according to the Associated Press (although it could still create a dirty bomb, they note). The plutonium core inside Fat Man was around the size of a soft ball and weighed 6.2 kg (13.6 pounds). So roughly 616,900 times more massive than the piece that’s currently unaccounted for. Still, it’s never great to hear that the people we trust to manage this potentially deadly substance are subject to the same human error and oversights as the rest of us. Let’s hope this incident is a good excuse to tighten up protocols.

Science Alert, 5 May 2018

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

Scientist develop Marine Skin, a smart patch, to monitor the behaviour of marine animals

2018-05-08

Engineers have developed a thin smart patch called Marine Skin that could make the study of the behaviour of marine animals easier and more informative. It is a system for electronic tagging of animals that is based on stretchable silicone elastomers that can withstand twisting, shearing, and stretching even when exposed to high pressures in deep waters. “The integrated flexible electronics can track an animal’s movement, diving behaviour, and the health of the surrounding marine environment in real time,” Joanna Nassar, who was one of the members of the King Abdullah University of Science and Technology team that developed the patch, said in a statement. “Using simple design tricks and soft materials, we were able to beat the current standard systems in terms of non-invasiveness, weight, operational lifetime and speed of operation,” Nassar added. In the current prototype, the location data is supplemented by recordings of water temperature and salinity. Additional sensing capabilities could be added in future. “We are consistently advancing the field of flexible and stretchable electronics by making electronic systems in which every component is physically flexible,” another team member Muhammad Mustafa Hussain, said. The data is currently retrieved via wireless connection when the tag is

Engineers have developed a thin smart patch called Marine Skin that could make the study of the behaviour of marine animals easier and more informative.

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removed. In future, the researchers hope to develop remote data retrieval procedures by overcoming the problems of transmitting signals through the water.

First Post, 7 May 2018

<http://www.firstpost.com>

Zebrafish Help Unlock Clues to Human Disease

2018-05-08

From floor to ceiling, in row after row of small, bubbling tanks, 30,000 tiny tropical fish are unlocking the secrets to diseases that have vexed generations of researchers and physicians. The humble zebrafish, an inch-and-a-half-long freshwater member of the minnow family, is native to the streams, ponds and puddles of the Himalayan region. It doesn't look much like a zebra, though it does have five horizontal stripes adorning either side. One of the most interesting things about zebrafish is that when they lose something — an eye, a fin, a tail, even individual cell types — they grow a new one. Because their genetic profile is remarkably similar to our own, zebrafish are also found in the Miller Research Building on the medical campus of The Johns Hopkins University, where they provide scientists with genetic clues to medical mysteries. The fish have helped investigators at Johns Hopkins make important breakthroughs toward regenerating eye tissue, understanding thyroid cancer and making sense of the DNA tangles that regulate cell activity. The Centre for Functional Investigation in Zebrafish — or the FINZ centre — is a research core facility of the McKusick-Nathans Institute of Genetic Medicine. Thirty different cores from departments across The Johns Hopkins University offer more than 500 different research-related services. The centres allow investigators to share valuable resources and expertise, saving both time and dollars. FINZ centre co-director Jeff Mumm, of the Wilmer Eye Institute and the McKusick-Nathans Institute, says that, in addition to three Johns Hopkins researchers currently maintaining tanks of fish there, the centre collaborates with other scientists. For a fee, FINZ offers numerous genetic services to colleagues throughout the institution, including modifying the genome to produce fish with traits that researchers want to study. For instance, a researcher wanting to study how the liver develops and functions can ask the FINZ centre to produce zebrafish with glowing livers. Taking a gene from jellyfish that enables their incandescent glow, the FINZ team introduces that gene into a zebrafish, lighting up the liver and allowing researchers to observe its growth and function. "That's the kind of work we do all the time," says Mumm. "It's a cheap and efficient

Research core allows investigators to share resources and save money.

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process to work with us to create genetically modified zebrafish for specific research needs." In 2004, geneticist Andy McCallion, along with former colleagues Shannon Fisher and Steven Leach, proposed that Johns Hopkins build its own zebrafish facility. McCallion, who co-directs the FINZ centre, and Fisher, now a faculty member at Boston University, convinced medical school leadership that zebrafish would offer a more efficient, less expensive way to do genetics research. McCallion and his lab team dig deep into genetic codes that control when and where genes are switched on/off, combining cutting-edge genomic tools and computational artificial intelligence to find the abnormalities that can influence diseases such as Parkinson's. He says that, while that work remains arduous, early in his career it was far more difficult. "We could see sequences that stood out as highly similar among different species, but we didn't have a large-scale, genomewide way to test our hypotheses," McCallion recalls. "We needed a way to test hundreds and hundreds of these things. For a lot of reasons, studying the fish gives us that ability." In addition to their genetic similarity to humans, zebrafish have other attributes that make them attractive to scientists who need to research large numbers of the same organism. The fish reproduce and mature quickly, they're easy to maintain and their eggs are fertilised outside their bodies, allowing researchers to harvest newly fertilized embryos. To produce the desired trait in a fish, they can introduce new genes or remove genes from the harvested embryos. And since zebrafish embryos are translucent, scientists can observe their development in real time, watching organs and whole systems grow from stem cells. Mumm says that, while science has focused on mice as models to study disease since the creation of the first genetically altered mouse in 1980, zebrafish have, in recent years, emerged as an important model species as well. For many years, fruit flies were the species of choice for genetics researchers, sharing better than 61 percent of genes with humans. And while the insects still play important roles, key physiological differences make fish, as fellow vertebrates, attractive. While zebrafish share about 71 percent of the human genome, in some key cases, fish genes are near-perfect matches for people. According to a 2013 study by British researchers, 82 percent of genes associated with human diseases and disorders have a zebrafish counterpart. Mice and humans are a closer genetic match, at about 85 percent. But Mumm says, "zebrafish provide a fresh perspective, affording unique opportunities beyond what is possible in mice." The Mumm Lab specialises in "high-throughput biology," where automated equipment processes large numbers of samples to enable large-scale chemical and genetic screening. This approach is difficult and expensive to apply to mice and thus has largely been limited to cell culture work. However, due to their small size, zebrafish have emerged as

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a living disease model platform for high-throughput drug discovery. The Mumm Lab has developed a zebrafish-based screening approach that evaluates drug effects faster than ever, processing tens of thousands of fish per day. Because their genes can be modified so inexpensively and in great numbers, Mumm says zebrafish allow scientists to pursue large-scale genetic research initiatives as well, interrogating the function of larger numbers of genes in shorter amounts of time.

Johns Hopkins surgeon Jason Prescott maintains numerous zebrafish tanks in the FINZ centre. Three days a week, he operates on patients who have thyroid cancer. But he also has a research lab aimed at, one day, reversing the disease's progress and eliminating the need for surgery. Zebrafish help Prescott better understand how genetic mutations can cause healthy thyroids to turn cancerous. "The goal is to put myself out of the surgery business," he says. Prescott and his lab team study the defective gene coding in patients who come to him for thyroid cancer surgery. When they isolate a patient's faulty gene, they introduce a similar gene in zebrafish. Then they observe the fish to learn the cancerous cells' origins and how they replicate. "The fish have thyroid glands that are very similar to ours," Prescott says. "Anatomically, they're in just about the same place and they perform a similar function. And because they're living, we can actually see the biology in real time, as it happens." The fish also allow for fast and efficient testing of drugs to combat disease. "By-passing more primitive screening techniques, we're able to save time and money by testing drugs on hundreds of fish at once," he says. In one example of Prescott's research, individual fish, genetically modified to have cancerous thyroids, are placed in shallow dishes of water. The fish have been engineered so that their thyroids glow when a particular drug causes a particular reaction. The researchers introduce various drug compounds to the water and study the results. Zebrafish have played a key role in Prescott's pursuit of pharmaceutical breakthroughs to combat thyroid cancer. "The gold standard for preclinical drug trials is to work with a living organism," he says. "It allows us a much more realistic environment than working with cells growing on a plate."

The Capacity for Self-Repair

Medical student Hannah Edelman is six years into her M.D./Ph.D. program, researching human genetics and paediatric diabetes. She spends many hours in the FINZ centre studying how zebrafish never get the disease. In type 1 diabetes, a patient's immune system attacks and destroys the cells in the pancreas that produce insulin, the hormone that regulates blood sugar. While humans cannot regenerate these cells, zebrafish can. "They

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can regrow pancreatic beta cells," she says, referring to the cells that store and release insulin. "I want to know what's so special that allows them to do this. We're trying to find a way for humans to be able to regenerate these cells. That would mean a lot in the treatment of type 1 diabetes." In Mumm's work studying degenerative eye disease, he takes advantage of the fact that humans and zebrafish share a trait — a specific cell type that can revert to being a stem cell — that allows them to produce new cells in response to injury or disease in the retina. Thus, both species have the capacity to produce new cells to heal the eye. "Somewhere along the way in their evolutionary selection, zebrafish developed the capacity for self-repair," says Mumm. The difference, Mumm says, is that, while the new cells lead to a brand-new retina in a zebrafish, humans are not so lucky. "For us, the new cells become scar tissue. It actually does humans more harm than good." In cell culture, however, these injury-responsive human retinal stem cells have the ability to produce new neurons. He hopes that by learning how the zebrafish's robust regenerative abilities are controlled, we can harness dormant regenerative capacities in patients with degenerative eye diseases. He says the fish are speeding up the process by helping eliminate the scientific dead ends faster than ever before. Combining these studies with the high-throughput screening techniques in his lab, Mumm says, "We can find out what doesn't work at step one rather than at step 52. That amounts to a whole lot of time and money saved."

John Hopkins Medicine, 7 May 2018

<http://www.hopkinsmedicine.org>

Oilseed crop's waste product yields compounds that protect skin from the sun

2018-05-08

Meadowfoam, a native Pacific Northwest plant cultivated as an oilseed crop, has emerged as a potential new source of protection against the sun's harmful effects on the skin. The findings by scientists at Oregon State University are important because nearly 10,000 people a day in the United States are diagnosed with skin cancer, resulting in large part from the DNA damage caused by the ultraviolet radiation the sun emits. In addition to cancer, prolonged exposure to the sun can lead to the skin's premature aging, visible in the form of sagging and wrinkles. "There's a highly complex cascade of biochemical reactions that occur as stress responses in the skin attempt to counteract UV-induced damage," said co-corresponding author Gitli Indra, associate professor of pharmaceutical sciences. "We need better ways to block UV

Meadowfoam, a native Pacific Northwest plant cultivated as an oilseed crop, has emerged as a potential new source of protection against the sun's harmful effects on the skin.

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exposure and also ways to lessen the damage by limiting detrimental physiological processes." Meadowfoam, named for the canopy of creamy-white flowers it produces when a crop is in full bloom, contains a class of compounds known as glucosinolates whose derivatives have been shown to have anti-cancer and sunlight-protectant properties. Indra and colleagues in the OSU College of Pharmacy looked at two derivatives from one such glucosinolate that's found readily in the "seedmeal" left over from meadowfoam oilseed processing; meadowfoam oil has industrial applications and also is used in shampoos and cosmetics. The scientists set up 3-D facsimiles of human skin reconstructed in culture plates, hit them with ultraviolet B radiation - the more harmful of the two types to reach the earth from the sun - and then treated the skin with the meadowfoam derivatives. Both of the derivatives - 3-methoxybenzylisothiocyanate and 3-methoxyphenylacetonitrile - ameliorated the UV damage to the skin cells by:

- prohibiting crosslinking of DNA, thereby preventing cancer-initiating mutations;
- inhibiting two enzymes involved in the breakdown of collagen, skin's primary structural protein;
- causing a reduction in the number of precancerous cells;
- and preventing hyperplasia - organ or tissue enlargement that's often an early stage in cancer development.

"DNA damage is the precursor to photocarcinogenesis, and these derivatives reduce that damage, which means improved skin health and reduced cancer risk," said Arup Indra, associate professor of pharmaceutical sciences, affiliate investigator at OSU's Linus Pauling Institute and the other co-corresponding author. "The findings show a tremendous potential for utility in skin care products, besides just demonstrating the science on its own." The 3D skin reconstructions used in the study represent an important research tool, added Gitali Indra. "It's very important to not use animal models in the testing of cosmetics and skin care products," she said. "People don't like to see animal testing data, especially in Europe, where they'll put a picture of a bunny rabbit on a product so people know animals weren't used in the testing. This is a very good model that we can use to test many kinds of drugs by using different assays." The skin reconstructions are built from scratch, Arup Indra noted, meaning, for example, pigment-producing cells and immune cells can be added as a study requires. "We can look at how a compound slowly diffuses and see how it impacts collagen degradation and UV protection," he said. "It's really nice that we can tease apart these different functions." Because the

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glucosinolate derivatives inhibit the enzymes needed for the breakdown of collagen, they're effectively acting as anti-aging compounds. "Most cosmetics just sort of patch things up, cover up the damage, but this actually protects the skin," said co-author Fred Stevens, principal investigator at the Linus Pauling Institute and professor of medicinal chemistry in the College of Pharmacy. Findings were published in *Frontiers in Pharmacology*. Natural Plant Products, Inc., of Salem, Oregon, supported this research.

Phys.org, 8 may 2018

<http://phys.org>

Flower-like nanostructures in sodium batteries

2018-05-08

Sodium-ion batteries (SIB) are hot candidates for a cheap and sustainable battery technology, but a recurring issue is anode instability. A Chinese team of scientists now reports the preparation of a submicron-size structured anode composite material that can accommodate large volume changes. The antimony sulfide electrode is easily prepared and exhibits superior capacity and cycling performance, as shown in a study published in the *European Journal of Inorganic Chemistry*. In contrast to lithium ion batteries (LIBs), sodium ion batteries rely on readily available and sustainable raw materials. One of the main reasons why SIBs are not yet widely applied is instability: The large sodium ion cannot integrate as easily in the electrodes as the small lithium ion, causing significant expansion and shrinkage of the structures during the discharging/charging events. This problem particularly refers to the anode, which simply pulverizes during longer cycling periods. Only if this issue becomes solved, a truly working sodium ion battery can be developed. Now, Guangda Li and his colleagues at Qilu University of Technology, Jinan, China, have combined micro- and nanostructured materials with state-of-the-art battery chemistry. They assembled an anode composite material that, through its flower-like submicrostructure, can mitigate the drastic volume changes while still showing improved conductivity and capacity. Moreover, it was easily prepared, the scientists reported. Antimony, or, even better, antimony sulfide, are attractive anode materials for SIBs. Their very high theoretical specific capacities result from the count of as much as three sodium atoms per antimony to be incorporated in the structure upon discharging (which in battery terms is sodiation), when the antimony sulfide first forms sodium sulfide and then antimony alloys. To reduce the effects of the large volume changes, microstructuring to a size

A Chinese team of scientists now reports the preparation of a submicron-size structured anode composite material that can accommodate large volume changes.

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between nano- and bulk materials has been proposed. In this regard, the Jinan scientists prepared spherical particles of antimony sulfide having two to three microns in diameter. A closer look revealed that the surface was composed of numerous thin sheets grown together to construct flowerlike structure. This “bunch of flowers” might serve as an effective buffer against volume changes, but its conductivity and diffusion paths are still too low for battery applications. Therefore, the authors coated it with a carbon layer made of polypyrrole polymer. “The PPy coating layers not only serve as the structural stabiliser [...], but can also enhance the conducting of antimony sulfide submicrospheres,” they explained. The final composite material had a well-defined shape and met the technical demands of a high-performance anode. The authors also emphasised that their preparation method was a straightforward sol-gel technology starting from antimony acetate (which leaves no harmful chloride in the end product) in combination with a smoothly proceeding polymerisation/coating step. This work signifies the recent advances made on sodium ion battery technology. It shows that the combination of nanoengineering strategies with battery electrochemistry may lead to products that can complement or substitute current lithium-ion technology.

Phys.org, 8 May 2018

<http://phys.org>

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Dark chocolate consumption reduces stress and inflammation

2018-05-10

New research shows there might be health benefits to eating certain types of dark chocolate. Findings from two studies being presented today at the Experimental Biology 2018 annual meeting in San Diego show that consuming dark chocolate that has a high concentration of cacao (minimally 70% cacao, 30% organic cane sugar) has positive effects on stress levels, inflammation, mood, memory and immunity. While it is well known that cacao is a major source of flavonoids, this is the first time the effect has been studied in human subjects to determine how it can support cognitive, endocrine and cardiovascular health. Lee S. Berk, DrPH, associate dean of research affairs, School of Allied Health Professions and a researcher in psychoneuroimmunology and food science from Loma Linda University, served as principal investigator on both studies. "For years, we have looked at the influence of dark chocolate on neurological functions from the standpoint of sugar content -- the more sugar, the happier we are," Berk said. "This is the first time that we have looked at the impact of large amounts of cacao in doses as small as a regular-sized chocolate bar in humans over short or long periods of time and are encouraged by the findings. These studies show us that the higher the concentration of cacao, the more positive the impact on cognition, memory, mood, immunity and other beneficial effects." The flavonoids found in cacao are extremely potent antioxidants and anti-inflammatory agents, with known mechanisms beneficial for brain and cardiovascular health. The following results will be presented in live poster sessions during the Experimental Biology 2018 meeting:

- Dark Chocolate (70% Cacao) Affects Human Gene Expression: Cacao Regulates Cellular Immune Response, Neural Signalling, and Sensory Perception. This pilot feasibility experimental trial examined the impact of 70 percent cacao chocolate consumption on human immune and dendritic cell gene expression, with focus on pro- and anti-inflammatory cytokines. Study findings show cacao consumption up-regulates multiple intracellular signalling pathways involved in T-cell activation, cellular immune response and genes involved in neural signalling and sensory perception -- the latter potentially associated with the phenomena of brain hyperplasticity.
- Dark Chocolate (70% Organic Cacao) Increases Acute and Chronic EEG Power Spectral Density (μV^2) Response of Gamma Frequency (25-40Hz) for Brain Health: Enhancement of Neuroplasticity, Neural Synchrony,

Findings from two new studies show dark chocolate consumption reduces stress and inflammation, while improving memory, immunity and mood.

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Cognitive Processing, Learning, Memory, Recall, and Mindfulness Meditation. This study assessed the electroencephalography (EEG) response to consuming 48 g of dark chocolate (70% cacao) after an acute period of time (30 mins) and after a chronic period of time (120 mins), on modulating brain frequencies 0-40Hz, specifically beneficial gamma frequency (25-40Hz). Findings show that this superfood of 70 percent cacao enhances neuroplasticity for behavioural and brain health benefits.

Berk said the studies require further investigation, specifically to determine the significance of these effects for immune cells and the brain in larger study populations. Further research is in progress to elaborate on the mechanisms that may be involved in the cause-and-effect brain-behaviour relationship with cacao at this high concentration.

Science Daily, 24 April 2018

<http://www.sciencedaily.com>

The Chilling Story of The 'Demon Core' And The Scientists Who Became Its Victims

2018-05-10

It was August 13, 1945, and the 'demon core' was poised, waiting to be unleashed onto a stunned Japan still reeling in fresh chaos from the deadliest attacks anyone had ever seen. A week earlier, 'Little Boy' had detonated over Hiroshima, followed swiftly by 'Fat Man' in Nagasaki. These were the first and only nuclear bombs ever used in warfare, claiming as many as 200,000 lives – and if things had turned out a little differently, a third deadly strike would have followed in their hellish wake. But history had other plans. After Nagasaki proved Hiroshima was no fluke, Japan promptly surrendered on August 15, with Japanese radio broadcasting a recorded speech of Emperor Hirohito conceding to the Allies' demands. As it turns out, this was the first time the Japanese public at large had ever heard one of their emperors' voices, but for scientists at the Los Alamos Laboratory in New Mexico – aka Project Y – the event had a more pressing significance. It meant the functional heart of the third atom bomb they'd been working on – a 6.2-kilogram (13.7 lb) sphere of refined plutonium and gallium – wouldn't be needed for the war effort after all. If the conflict had still been raging, as it had for almost five straight years, this plutonium core would have been fitted into a second Fat Man assembly and detonated above another unsuspecting Japanese city just four days later. As it was, fate issued those souls a reprieve, and the Los Alamos device –

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code-named 'Rufus' at this point – would be retained at the facility for further testing. It was during these tests that the leftover nuke, which ultimately became known as the demon core, earned that name. The first accident happened less than a week after Japan's surrender, and only two days after the date of the demon core's cancelled bombing run. That mission may have never launched, but the demon core, stranded at Los Alamos, still found an opportunity to kill. The Los Alamos scientists knew well the risks of what they were doing when they conducted criticality experiments with it – a means of measuring the threshold at which the plutonium would become supercritical, the point where a nuclear chain reaction would unleash a blast of deadly radiation. The trick performed by scientists in the Manhattan Project – of which the Los Alamos Lab was a part – was finding how just how far you could go before that dangerous reaction was triggered. They even had an informal nickname for the high-risk experiments, one which hinted at the perils of what they did. They called it "tickling the dragon's tail", knowing that if they had the misfortune to rouse the angry beast, they would be burned. And that's exactly what happened to Los Alamos physicist Harry Daghlian. On the night of August 21, 1945, Daghlian returned to the lab after dinner, to tickle the dragon's tail alone – with no other scientists (just a security guard) around, which was a breach of safety protocols. As Daghlian worked, he surrounded the plutonium sphere with bricks made of tungsten carbide, which reflected neutrons shed by the core back at it, edging it closer to criticality. Brick by brick, Daghlian built up these reflective walls around the core, until his neutron-monitoring equipment indicated the plutonium was about to go supercritical if he placed any more. He moved to pull one of the bricks away, but in doing so accidentally dropped it directly onto the top of the sphere, inducing supercriticality and generating a glow of blue light and a wave of heat. Daghlian reached out immediately and removed the brick, noticing a tingling sensation in his hand as he did so. Unfortunately, it was already too late. In that brief instant, he had received a lethal dose of radiation. His burnt, irradiated hand blistered over, and he eventually fell into a coma after weeks of nausea and pain. He was dead just 25 days after the accident. The security guard on duty also received a non-lethal dose of radiation. But the demon core was not yet finished. Despite a review of safety procedures after Daghlian's death, any changes made weren't enough to prevent a similar accident occurring the following year. On May 21, 1946, one of Daghlian's colleagues, physicist Louis Slotin, was demonstrating a similar criticality experiment, lowering a beryllium dome over the core. Like the tungsten carbide bricks before it, the beryllium dome reflected neutrons back at the core, pushing it toward criticality.

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Slotin was careful to ensure the dome – called a tamper – never completely covered the core, using a screwdriver to maintain a small gap, acting as a crucial valve to enable enough of the neutrons to escape. The method worked, until it didn't. The screwdriver slipped and the dome dropped, for an instant fully covering the demon core in a beryllium bubble bouncing too many neutrons back at it. Another scientist in the room, Raemer Schreiber, turned around at the sound of the dome dropping, feeling heat and seeing a blue flash as the demon core went supercritical for the second time in the space of a year. "The blue flash was clearly visible in the room although it (the room) was well illuminated from the windows and possibly the overhead lights," Schreiber later wrote in a report. "The total duration of the flash could not have been more than a few tenths of a second. Slotin reacted very quickly in flipping the tamper piece off." Slotin may have been quick in rectifying his deadly mistake, but again, the damage was already done. He, and seven others in the room – including a photographer and a security guard – were all exposed to a burst of radiation, although Slotin was the only one to receive a lethal dose, and a greater one than that inflicted on Daghlian. After an initial bout of nausea and vomiting, he at first seemed to recover in hospital, but within days was losing weight, experiencing abdominal pain, and began showing signs of mental confusion. A press release issued by Los Alamos at the time described his condition as "three-dimensional sunburn". Nine days after the screwdriver slipped, he was gone. The two deadly accidents, only months apart, finally saw real changes take place at Los Alamos. New protocols meant an end to 'hands on' criticality experiments, with scientists forced to use remote control machinery to manipulate radioactive cores at a distance of hundreds of metres. They also stopped calling the plutonium core 'Rufus'. From then on, it was known only as the 'demon core'. But after everything that had happened, the leftover nuke's time was up too. Following the Slotin accident – and the core's resultant increase in radiation levels – plans to use it in Operation Crossroads, the first post-war nuclear explosion demonstrations to commence at the Bikini Atoll a month later, were shelved. Instead, the plutonium was melted down and reintegrated into the US nuclear stockpile, to be recast into other cores as necessary. For the second and last time, the demon core was denied its detonation. While the deaths of two scientists can't be compared to the untold horrors if the demon core had been used in a third nuclear attack against Japan, it's also easy to understand why the scientists gave it the superstitious name they did. Then there are the weird details that fill in the backdrop of the story. Like how Daghlian and Slotin weren't just killed by similar accidents involving the same plutonium core: both incidents took place on Tuesdays, on the 21st day of the month, and the men even

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passed away in the same hospital room. Of course, those are just coincidences. The demon core wasn't actually demonic. If there's an evil presence here, it's not the core, but the fact that humans rushed to make these terrible weapons in the first place. And the real horror – besides the horrible effects of radiation poisoning – is how spectacularly mid-20th century scientists failed to protect themselves from the extreme dangers they were toying with, despite fully knowing the grave risks in their midst. According to Schreiber, Slotin's first words immediately after the screwdriver incident were simple, and already resigned. He had comforted his dying friend Daghlian in hospital, and he knew what came next. "Well," he said, "that does it."

Science Alert, 28 April 2018

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

A Skin Cancer Expert Says The Idea You Need to Soak Up Vitamin D From The Sun Is Flawed

2018-05-09

No doubt about it: your body needs vitamin D to stay strong and healthy. The naturally occurring steroid helps our bodies absorb calcium and build bones. Without enough of the vitamin, kids can develop a brittle bone condition called rickets, and adults can suffer from a similar condition called osteomalacia. But while many love to talk about getting outside for a fresh hit of the "sunshine vitamin" every day, the truth is that most people already get plenty of the nutrient from the things they put in their mouth, like foods and supplements, as well as a normal, unaggressive amount of Sun exposure. There's no need to crisp your skin to get your needed dose of vitamin D.

How much vitamin D is enough?

The US National Institutes of Health recommends the average adult consume around 600 IU (international units) of vitamin D a day. Their recommended dose is a little less for babies (400 IU) and a little more for adults over 70 years old (800 IU). For reference, that means you can get pretty close to an entire day's supply of vitamin D from eating a three-ounce serving of salmon (~450 IUs), plus downing one cup of fortified milk (~120 IUs) or sipping on a cup of vitamin D-fortified orange juice (~140 IUs). How much vitamin D you can get from being out in the Sun depends on a host of factors, including air pollution, the shade of your skin, as well as your age, weight, and even how warm your skin is when you're outside.

**No doubt about it:
your body needs
vitamin D to stay
strong and healthy.**

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As many as 41 percent of American adults between the ages of 20-64 may not be getting their recommended amount of vitamin D. Yet the Centers for Disease Control and Prevention reports that African-Americans, who have some of the highest rates of vitamin D deficiency, have greater bone density than other ethnic groups, and fewer fractures. This suggests the vitamin D and bone health equation is more complicated than just a numbers game. David Leffell, author of *Total Skin: The Definitive Guide to Whole Skin Care For Life*, and chief of dermatologic surgery at Yale School of Medicine, told Business Insider that going unprotected in the Sun just to get an additional hit of vitamin D from baking in the Sun is a pretty dangerous idea, and completely unnecessary. "You don't need to live under a rock," he said, but staying protected from skin-burning UVB rays when you're outside this summer is an important way to prevent skin cancer. Leffell recommends his patients carry some sunscreen with them when they spend time outside, even on cloudy or rainy days, so they can have it on hand and apply some if the Sun does start to shine. This is especially important during the warmer summer months, when the UV Index rises and the Sun becomes more potent.

How much Sun protection do you need? And where should you put it?

Leffell says he uses an SPF-30 cream himself, and for most people, that gives enough of a shield to fight off about 96 percent of the damaging, burn-inducing UVB solar rays at the beach. More sensitive and fairer-skinned folks may opt for an SPF-50 option, but Leffell says any SPF higher than 50 only offers "minimal" extra benefits. Whatever dosage you pick, remember that it doesn't last all day. SPF numbers indicate the level of protection you can get only for the first two hours after you apply a sunscreen. After that, they're no longer as effective. So Leffell says while he knows it's a chore, it's essential to "refresh" sunscreen in burn- and skin cancer-prone areas of the body and face like the top of the ears, the forehead, the cheeks, and the nose. Sun-protective clothing can also help out with other hard-to-reach spots like the back and shoulders. And there are a few choice spots on the body where it's especially important to re-apply, because they tend to be zones where men and women develop skin cancer most often. Leffell says women should be especially careful to protect the "v" of their chest from getting burned, since damage there is "very hard to reverse cosmetically with lasers." For men, he recommends anyone who's lost a bit of hair should liberally apply sunscreen to their

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bald spots and their neck, and add a hat, too. "We see a lot of skin cancer on the scalp," Leffell said.

Science Alert, 29 April 2018

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

A New Study Could Explain Why Some Guys Get Grey Hair Early

2018-05-10

Why do some guys go grey in their 20s, while others reach their 40s without a single silver strand in sight? We know that genetics play a role in the greying process, but scientists still haven't pinpointed the exact reason some guys become silver foxes before others. A study published in the journal PLOS Biology may bring us one step closer to an answer. According to the new research, a gene that helps regulate our immune systems also helps regulate hair colour. The study was conducted on mice, but it may eventually help explain why guys go grey when they do. According to Gizmodo, study co-author Melissa Harris — a biology professor at the University of Alabama at Birmingham — decided to study melanocyte cells in lab mice to better understand aging (we lose these cells as we get older). Her team studied one particular gene found in melanocyte cells: melanogenesis associated transcription factor, or MITF. The gene helps control the production of melanin. First, the researchers looked at mice that were bred to go grey early and found that these guys created a lot of the MITF gene. Harris theorised that more MITF decreased the number of melanocyte cells — therefore creating less melanin. Less melanin means more grey hair. They also engineered mice to make less of the MITF gene, thinking it would slow the greying process — but they were surprised to find the mice went grey just as quickly. Though puzzled at first, Harris' team discovered that mice with small amounts of the MITF gene had more of a protein found in the immune system called interferons. Interferons help your body protect against invaders like cold and flu viruses. Essentially, higher levels of the MITF gene were associated with lower levels of interferon proteins. The researchers concluded that when there were too many interferons, the mice's immune systems didn't know how to behave and attacked melanocyte cells instead of just foreign viruses. It's not clear whether having more of the MITF gene decreased the interferons, or whether having more interferons decreased the MITF gene levels. We simply know there could be a relationship between the immune system and a gene that contributes to our hair colour. Of course, this is just a starting point for more research on the link between the immune system

A new study found that a gene that contributes to hair colour also keeps our immune systems running smoothly. This finding could explain why some people grey prematurely

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and grey hair. The researchers say their findings may also help explain other conditions involving pigmentation, like vitiligo. For now, you'll just have to rely on hair dye — or own those greys like Clooney.

Popular Mechanics, 6 May 2018

<https://www.popularmechanics.com>

Fasting For Just 24 Hours Boosts The Regeneration of Stem Cells, Study Finds

2018-05-10

For decades, numerous studies have shown that strict, low-calorie-intake diets could be the key to having a longer, healthier life. But why is this so anyway? A new study examining the effects of fasting in mice looks to have one answer, finding just 24 hours of calorie restriction flicks a metabolic switch that can boost the regeneration of stem cells in the gut. These intestinal stem cells fail to regenerate as effectively when we get older, and since they're important for helping us to maintain healthy tissue and fight off disease, this cellular kick-starter is a pretty valuable thing to know about. "Fasting has many effects in the intestine, which include boosting regeneration as well as potential uses in any type of ailment that impinges on the intestine, such as infections or cancers," says MIT biologist Omer Yilmaz. "This study provided evidence that fasting induces a metabolic switch in the intestinal stem cells, from utilising carbohydrates to burning fat." In the study, that conversion didn't just mean cells use up fat as an energy source instead of carbohydrates. Making the switch also enhanced their functioning. Intestinal stem cells, which the researchers describe as the "workhorses of the intestine", typically renew intestinal lining in about five days, but with the metabolic switch activated, it's possible this renewal could be fast-tracked. In the lab, Yilmaz's team took intestinal stem cells from mice that had fasted for 24 hours and grew them in culture to grow masses of cells called organoids, a kind of organ-like 'mini intestine'. When they did this, they saw the regenerative capacity of the stem cells from fasting mice was double that of regular mice that hadn't fasted. "It was very obvious that fasting had this really immense effect on the ability of intestinal crypts [glands] to form more organoids, which is stem-cell-driven," says one of the team, biomedical researcher Maria Mihaylova. "This was something that we saw in both the young mice and the aged mice, and we really wanted to understand the molecular mechanisms driving this." To find out, the teams sequenced the messenger RNA of stem cells from the fasting mice and found that the fasting had activated transcription factors called peroxisome proliferator-activated

This study could even lead to 'fasting' in a pill.

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receptor, or PPARs, which turn on genes involved in metabolising fatty acids. In this case, that activation induced the cells to break down fatty acids instead of glucose, while simultaneously boosting the ability of the cells to regenerate themselves. When they blocked the PPAR activation, the regeneration boost ended, but that's not all the team discovered. By treating mice with a molecule called GW501516 that activates the effects of PPARs, it reproduced some of the beneficial effects of fasting in mice. "That was also very surprising," says one of the researchers, Chia-Wei Cheng. "Just activating one metabolic pathway is sufficient to reverse certain age phenotypes." There's still a lot more for the researchers to investigate before we fully understand the extent of this metabolic switch and its functioning – let alone whether it's as easily manipulated in humans as it is in mice. But it certainly inches us closer to the potential prospect of activating this metabolic switch somehow in a pill or other drug treatment, boosting intestinal health in patients without requiring them to fast – and maybe, just maybe – helping us to live longer. Those results might not be locked in yet, but they're starting to look more viable than ever. "In a beautiful set of experiments, the authors subvert the system by causing those metabolic changes without fasting and see similar effects," says biochemist Jared Rutter from the University of Utah, who wasn't involved in the research. "This work fits into a rapidly growing field that is demonstrating that nutrition and metabolism [have] profound effects on the behaviour of cells and this can predispose for human disease." The findings are reported in *Cell Stem Cell*.

Science Alert, 7 May 2018

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

Cinco de Mayo: Tequila is Good for Your Bones, According to Science

2018-05-10

There are many reasons to drink tequila. It's a liquor with a storied history and its very molecular makeup offers key insights in the fight against climate change. Also, it's delicious. But new research suggests that the Mexican liquor could help fight osteoporosis, as well. A study originally published in the Spanish-language journal *Investigación y Desarrollo* found that the blue agave plant used to make tequila has substances capable of improving the body's absorption of calcium and magnesium. Lead by Dr. Mercedes López of Mexico's Centre for Research and Advanced Studies, or Cinvestav, researchers found that not only did tequila consumption help maintain bone health, but the fructans found

New research suggests that the Tequila could help fight osteoporosis.

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in agave could promote the formation of new bone, even in patients suffering from osteoporosis. To reach this conclusion, López administered agave fructans, which are non-digestible carbohydrates, to female mice with induced osteoporosis. She found that mice who ingested the fructans produced nearly 50 percent more osteocalcin than mice who did not. Not only that, but other studies from López conducted at the National Polytechnic Institute in Guanajuato, Mexico, found that the agave fructans stimulate the production of greater amounts of incretins than fructans found elsewhere. Incretins are a group of gastrointestinal hormones that increase the amount of insulin released by the pancreas, meaning this could be beneficial to diabetics. "Experimental studies suggest that fructans may be beneficial in diabetes, obesity, stimulating the immune system of the body, decreasing levels of disease-causing bacteria in the intestine, relieving constipation, and reducing the risk of colon cancer," she said at the 239th National Meeting of the American Chemical Society. There are more than 3 million cases of osteoporosis in the United States each year and roughly 200 million people worldwide. While more research needs to be conducted to confirm that the agave's fructans could help with bone growth, luckily the plant grows in abundance in Mexico and López is eager to continue research. "We still have a long way to go to determine for which health benefits agave fructans perform better than [other] fructans," she said. "However, the early results are encouraging, and we're working on it."

Inverse, 5 May 2018

<https://www.inverse.com>

How atmospheric dust might help cool the planet

2018-05-10

As the earth continues to warm, it is becoming increasingly clear that we cannot ignore the possibilities of geoengineering, the branch of science that develops techniques to artificially cool the planet. Indeed, it may soon become necessary to take drastic action to prevent the worst effects of climate change. However, that doesn't mean that geoengineering experiments should be undertaken without caution and care, because the underlying impact of those experiments could very well end up causing more harm than help. Iron fertilisation as a geoengineering method was mostly considered in the late 1990s to early 2000s, and as an idea, it came about because of a very fundamental oceanographic question: why do certain areas of the ocean have very low amounts of plankton, even when they have enough nutrients for those plankton to grow? In most areas

New research suggests an old idea of geoengineering has more merit than long suspected

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of the ocean, phytoplankton, the tiny plant-like creatures that produce most of the oxygen in the ocean (and about half of the oxygen on the planet), need only two things to grow: light and nutrients. But there are some areas of the ocean that contain high levels of nutrients and no phytoplankton, even during times of the year when light conditions are right. These regions, called high-nutrient, low-chlorophyll regions, puzzled oceanographers until 1990, when a scientist named John Martin proposed that iron might be the missing link.

The limits of iron

Iron is a micronutrient — living things don't need a lot of it, but what they do need, they can't do without. Places like the Southern Ocean, off the coast of Antarctica, have almost no iron at all. This is because iron is a terrestrial micronutrient, meaning it comes from the land. The most common sources of iron to the ocean are rivers and wind-blown dust from deserts. Antarctica, covered in ice and isolated from other continents, has none of that. Martin proposed that that was why the phytoplankton weren't growing. To prove it, scientists went out and conducted iron fertilization experiments by artificially adding iron to the ocean and see if the phytoplankton grew. Within a day of adding dissolved iron into the ocean, scientists observed a phytoplankton bloom. That research was interesting and exciting, but the most exciting part for some people was an interesting link between phytoplankton and carbon dioxide. See, just like plants on land, phytoplankton are photosynthesizers. They use up carbon dioxide to create oxygen, and with so much open, iron-limited space in the Southern Ocean, oceanographic researchers across multiple institutions worldwide started to wonder if, with just enough iron, we could stop climate change completely. It didn't work out quite that nicely. Artificial iron fertilisation was proven to be ineffective at removing carbon from the atmosphere. And over concerns, published in a letter to *Science* in 2008, that continuing to conduct these studies might harm the natural environment by allowing invasive species to grow or by altering the ecosystem in ways they couldn't predict, the research was effectively halted. (Some continued under the table. In 2012, a US-based entrepreneur named Russ George defied an ocean-dumping moratorium, convincing the Haida Nation to conduct an iron fertilization project off the coast of British Columbia, Canada, to boost salmon populations, with the idea that salmon would feed off of the resulting phytoplankton bloom. According to *Nature*, scientists have seen no evidence that the scheme worked.) Since 2008, there have been almost no papers talking about iron in the Southern Ocean affecting the climate. However, new research by

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Gary Shaffer, a researcher at the University of Magallanes in Punta Arenas, Chile, and Fabrice Lambert, an assistant professor at the Pontifical Catholic University of Chile, suggests that the question of iron isn't fully closed. Their research, which is focused on atmospheric dust, a major source of oceanic iron, suggests that dust, and the iron in it, may have contributed to the onset of the ice ages. And understanding how the Earth has naturally cooled in the past, prior to human intervention, would allow us to better understand how Earth might cool in the future.

Simulating sun and iron

Ice ages are actually regular events. Over the past 800,000 years, we've had eight. To a certain extent, they can be explained by variations in Earth's orbit. However, one curious thing about the past few ice ages is that our records show a decrease of carbon dioxide during them, contributing to global cooling via reflection, where dust particles in the atmosphere reflect incoming sunlight back out into space, and iron fertilisation. And while Antarctica is usually far away from any sources of dust, Shaffer and Lambert's research, which combines records taken from dust measurements in ice cores over the past 300,000 years with temperature measurements calculated from those same ice cores in Greenland and Antarctica, shows that the amount of dust in the atmosphere increased greatly just before the start of the last three ice ages. While they state that this effect is not strong enough to cause an ice age on its own, the correlation is compelling, and Shaffer and Lambert make a convincing case that dust in the atmosphere might have provided the final push into an ice age. Using computer model simulations, they tested both the effect of reflection of sunlight and iron fertilisation, and both appeared significant. Their research suggests that iron fertilization may play a part in cooling the earth after all. However, that still doesn't mean that iron fertilisation is the solution to climate change. Shaffer and Lambert's work showed that iron can contribute to an ice age that's already in development, not that it can start an ice age from scratch. The potential risks of artificial iron fertilisation still need to be examined carefully before reopening the idea of using it for geoengineering so that we can fully understand the effects that this technique has on the natural environment and be prepared for any consequences that might result.

Salon, 6 May 2018

<https://www.salon.com>

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The team found many noxious chemical elements in the plastics from Lake Geneva

2018-05-10

In 2016 a team of scientists scoured a dozen beaches around the shores of Lake Geneva in Switzerland – not for flora or fauna, but for litter. In particular, plastic litter. It wasn't hard for them to amass quite the collection of discarded common everyday objects. These included bottle tops, cotton buds, pens, toys and straws. They picked up lesser identified fragments too, such as blocks of polystyrene foam, the kind that keeps fragile goods soft in the post. Collecting this debris wasn't the team's main goal, says Montserrat Filella from the University of Geneva. Instead, they wanted to assess whether chemicals emitted from these plastics were harmful. Their analysis comes at a time when the world is uncomfortably waking up to the extent of human-caused plastic pollution – from islands of amalgamated plastic in our ocean to the smaller microplastics in riverbeds.

We have reached, as the UN has recently dubbed it, a “planetary crisis” that is ruining our ecosystem. Despite the increased awareness of its damage, plastic pollution is already everywhere. While potential solutions like a plastic-eating enzyme – announced in April 2018 – may someday help us cut down waste, there is no guarantee that it could tackle the millions of tonnes of waste already in nature. But marine plastic pollution is much better studied and understood than that found in freshwater sources. “Freshwater systems are increasingly studied but still at a much smaller scale than oceans,” says Filella. This may simple be due to the fact that initial studies focused on the ocean – and so research proposals and grants followed suit. It didn't take long for the Geneva team to find what they were looking for. Filella and colleagues collected over 3,000 samples. They went on to analyse 670 of these, revealing some worrying results. Many of these samples contained hazardous and toxic elements including cadmium, mercury and lead – in some cases in “very high concentrations”, as outlined in a 2018 paper in the journal *Frontiers of Environmental Science*. A large proportion of these toxic elements are now banned or restricted. This “reflected the age and residence time of the plastic stock in the lake,” says Filella: the plastic waste has been building up over several decades. And as we know, plastic can take hundreds of years to degrade. These types of plastics are in line with what washes up on many beaches. But there was one major difference. The hazardous elements the team found “appear to occur in higher abundance in the plastics retrieved from Lake Geneva” than in samples from the ocean, says Filella. Its effect on

Much of the focus on plastic pollution centres on our oceans. Emerging evidence shows it's also a problem in fresh-water, which may even be the source.

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wildlife therefore remains a major concern. Plastic's prevalence in water and on the shorelines of beaches, lakes and rivers, means that it can, and often is, ingested by wildlife. If an animal swallows it, their stomach acids might speed up how quickly the plastic degrades – potentially thereby also releasing the hazardous elements faster. Then there is the effect on the animal itself. Due to the lack of studies, it's not yet entirely clear how freshwater organisms cope when they ingest plastic waste. Martin Wagner of the Norwegian University of Science and Technology spends much of his time looking at the effects of this. He was pleased to find that only when exposed to much higher concentrations of microplastics than are currently found in lakes and rivers did the species he examined appear to suffer. He's still concerned. His study was on one small invertebrate species – and we know that there are many other effects of ingesting plastic already documented in marine animals. Studies show that sea turtles routinely die when plastic blocks their digestive tracts, for instance. Plastics can also damage stomach linings, block digestive tracks or can cause entanglement. Filella suspects this is happening in fresh water too. "You might need a lot of plastic to kill a water flea, but that does not tell you the long-term consequences and the ecological implications," he says. "Plastics will not go away. They are in the environment and will stay there for decades." Lake Geneva is not an outlier. Other lakes show similar levels of pollution. Italy's Lake Garda, for example, also has high levels of plastic waste. A sample from the northern part of the lake contained 1,000 large plastic particles and 450 smaller particles (microplastics) per square metre. Microplastics are particularly pernicious, as highlighted in a 2015 study. These are tiny fragments, often 5mm or smaller, often the broken-down pieces of larger plastics. They are widely found in lakes and riverbeds, particularly in the sediment, and are easily mistaken for food. Some come from plastic fibres from our clothing, others from cosmetic products that contain microbeads (now banned in the UK). One study even found microplastics in drinking water. Another discovered them in beer and honey. But "the extent and relevance of their impacts on aquatic life" is not yet understood, the 2015 study reported. Nor is it clear how this might impact human health, something the authors say is "concerning". The team's leader Dafne Eerkes-Medrano explains that when it comes to freshwater, the more we look for plastic pollution, the more we will find. Even in the remote Mongolian Lake Hovsgol, microplastics are abundant – samples revealed a maximum of 44,435 microplastics discovered per square km, almost as much as in Lake Geneva, which had 48,146 per square km. Some of these are distributed by wind from the more populated parts of the lake, an analysis found. It is now becoming clearer that much of the plastic that ends up in the ocean starts off in freshwater

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bodies in the first place – estimates suggest it could be as much as 70-80%. It can originate from industrial plants next to rivers, says Wagner. There is no single solution for our plastic problem, particularly as plastic is so abundant in many everyday products we use. That's why Wagner urges us all to "go back to the source of the problem" to think more about how we reduce our use of plastic, from the packaging on our food to single-use coffee cups. "We should abandon the logic of producing, using and throwing away, but try to create an economic system where it all goes back" into use, he says. Reducing our use of plastic may slow down the waste that washes up on beaches – and plastics we use today are less toxic than they were in the past. But as the insights into Lake Geneva reveal, for many decades, at least, the plastic at the bottom of lakes will continue to release toxic elements. "It might take decades to get rid of the problem," says Filella.

BBC Future, 30 April 2017

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

Using candles rather than bright lights at night may help you sleep better

2018-05-10

We spend a third of our lives either sleeping... or trying to get to sleep. But in the world of 24/7 living and artificial light, our sleep is increasingly under threat. Many of us don't get the recommended seven to nine hours we need each night and struggle to get up in the mornings – especially on work days. But it isn't only our quantity of sleep that's affected. Since the discovery that light (particularly blue light, emanating from devices like smartphones) can affect our biological clocks, evidence has been building that exposure to even low levels of light in the evening or at the night is disrupting our sleep quality, as well. So, what would happen if we turned off the lights? Would it improve our sleep or have other benefits? And how easy would this be to achieve in a modern city? One recent winter, I decided to find out. Working with sleep researchers Derk-Jan Dijk and Nayantara Santhi at the University of Surrey, I designed a program to go cold-turkey on artificial light after dark, and to try to maximise exposure to natural light during the day – all while juggling an office job and busy family life in urban Bristol. The discoveries I've made have revolutionised my attitude to light – and how I live my life during the night and day. I now make simple, daily choices that can transform how I sleep, how I feel and perhaps even my cognitive abilities. Could you be doing the same? For millennia, humans lived in synchrony with the natural cycle of light

We spend a third of our lives either sleeping... or trying to get to sleep.

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and dark. This doesn't mean that everyone went to sleep as soon as the Sun set. Studies of pre-industrial societies, such as tribes living in Tanzania or Bolivia today, suggest that people stay up for several hours after dark, often socialising by firelight. In fact, the amount of sleep they get is quite like people in industrialised countries, but the timing is more in line with the natural cycle of day and night: they tend to go to bed earlier and get up just before dawn. "In modern societies, at least on weekdays, we don't sleep in tune with our body clock," says Dijk. Exposure to artificial light at night is shifting our body clocks later. But we still need to go to work in the morning, so we set an alarm clock – even though the biological clock says we should still be asleep. Pre-industrial societies such as the Hadza tribe in Tanzania also seem to have a far lower prevalence of sleep problems, like insomnia. "When we asked members of the Hadza whether they thought their sleep was good, they almost universally said 'yes, it's totally fine'. That statistically doesn't match up with what we see in the West," says David Samson, an anthropologist at the University of Toronto in Mississauga, who has studied them.

Light has a powerful non-visual effect on our body and mind, something to remember when we stay indoors all day and have lights on late into the night. Why is this? Light enables us to see, but it affects many other body systems as well. Light in the morning advances our internal clock, making us more lark-like, while light at night delays the clock, making us more owl-like. Light also suppresses a hormone called melatonin, which signals to the rest of the body that it's night-time – including the parts that regulate sleep. "Apart from vision, light has a powerful non-visual effect on our body and mind, something to remember when we stay indoors all day and have lights on late into the night," says Santhi, who previously demonstrated that the evening light in our homes suppresses melatonin and delays the timing of our sleep. However, light also boosts alertness in its own right. It's like drinking a double espresso. Although these stimulant effects are bad news if you're trying to sleep, being exposed to more bright light during the daytime could make us more alert. Light also stimulates brain regions that regulate mood. "The important thing is that we create a light exposure pattern with sufficient light during the day, and not too much light in the evening," says Dijk. Despite this logic, persuading my family to let me switch to this way of living took some effort. When I suggested to my husband that living by candlelight might be romantic, he rolled his eyes. But convincing him was a doddle compared to my six-year-old daughter and four-year-old son. Here's how that conversation went:

Me: Children, we're going to try living in the dark for a few weeks

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Daughter: But that will be spooky.

Me: No, I think it could be lots of fun. We'll have candles.

Daughter: *bursts into tears*

Me: Please don't cry. It will be like going camping.

Son: Can we have marshmallows?

Several packets of marshmallows later, we were set – although I agreed that my husband could occasionally use electric lighting and the kids could watch television, provided I wasn't nearby. Because I needed to maintain a normal work schedule, I also decided to keep the lights on until 18:00, although I switched my laptop to 'night mode' after sunset. The protocol looked like this: during the first week, I would try to maximise my exposure to daylight by moving my desk next to the window, lingering in the park on the way back from school drop-off each morning, getting outside at lunchtime and trying to exercise outdoors. The second experimental week would be spent minimising my exposure to artificial light after 18:00, relying on candle-light or dim red lighting instead. Then I would combine the two. In between each of these intervention weeks, I would lead a normal life. These weeks would function as a baseline. To track my responses, I'd wear an 'actiwatch' to measure light exposure, activity and sleep. I'd also complete sleep diaries and questionnaires to assess my sleepiness and mood and undertake a battery of cognitive tests to assess my short-term memory, attention and reaction speeds. On the last evening of each week, I would spend the evening in darkness, taking hourly samples of my melatonin, which is released in response to a signal from the biological clock and therefore provides a marker of our internal time. "Melatonin is our hormone of darkness; it creates the biological night," says Marijke Gordijn, a chronobiologist at the University of Groningen in the Netherlands, who measured my melatonin levels. The idea was to see if these changes to my light exposure altered the timing of my biological clock. We were curious to see if any of the benefits predicted by larger, well-controlled laboratory studies would translate into real life. "We've done a lot of experiments where we've given a dose of light and seen that it shifts the clock," says Gordijn. "But if we want to apply those findings to help people, we need to know that it will have the same effect when the environment is more variable."

Switched on

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And so, on a bright and sunny December morning, I found myself in the local park, inconspicuously trying to work out on the monkey-bars and swings instead of going to a body pump session in the gym. "Mummy, what's that lady doing?" asked a small boy. Because it was winter and most people were inside keeping warm, the park was largely deserted. Motivation had been a struggle for me also. It's hard to overcome the belief that because it's winter, it will be cold and miserable outside. However, I was reminded of something a Swedish friend used to say: there's no such thing as bad weather, only inappropriate clothing. And I soon realised that it's rarely as bad outside as it may look. Indeed, the more I did it, the more I came to regard getting outdoors in winter as a treat, rather than a chore. On another morning, I sat in the park with a cup of tea on my way back from dropping the kids at school and got out my light meter. The illuminance of light is measured in lux. On a cloudless day in summer, the light outdoors can reach as high as 100,000 lux; on an overcast day, it can be as low as 1,000 lux. Today, the reading was 73,000 lux. Back indoors, I took a reading in the centre of my shared office: 120 lux – lower even than the 500 lux you'd expect outdoors immediately after sunset. Horrified, I returned to my temporary desk by the window, where it was colder, but a sunnier 720 lux. Despite my best efforts to get more daylight during the intervention weeks, my average light exposure between 7:30 and 18:00 was 397 lux during the first week and just 180 lux during the second. This was presumably because I still spent most of the day indoors, working at my computer, and because the Sun set at around 16:00. The likely reason for this variation was the weather. During the first week, there were 4.5 hours of bright sunshine per day on average, whereas in the second week it was just 0.9 hours. This was still an improvement on baseline weeks, though, when my average daytime exposure was just 128 lux. It wasn't only the weather that proved challenging. For the first few nights of the experiment, we slept with the curtains open to maximise exposure to the dawn light. Light at this time is thought to shift the body clock earlier. But at night-time, the light from the streetlights made it difficult to sleep. I'm not alone in experiencing this problem. In 2016, researchers reported that people living in urban areas of more than 500,000 people are exposed to night-time light levels that are three to six times brighter than people in small towns and rural areas. Those living in areas of more intense light sleep less, are more tired during the daytime, and report feeling more dissatisfied with their sleep. They also go to bed and wake up later than people in darker areas. After a few days of this, I began closing the curtains and using a dawn simulation clock instead. It was an imperfect solution, as the light from these devices isn't as bright as daylight. But it was better than nothing. If exposing myself to more

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daylight wasn't hard enough, I also had to eliminate evening light during December, the darkest month of the year. Doing so brought home to me just how useful artificial light is. Cooking by candle-light was a daily challenge, chopping vegetables an outright hazard. I began to prepare meals earlier in the day, which ate into my work time and meant I got less done. Eventually, I employed another work-around. I installed some smart lightbulbs in my kitchen, that could be dimmed and colour-adjusted using an app on my smartphone. This, of course, created a paradox: to remove the alerting blue light from the bulbs, I had to expose myself to blue light from my phone, so I did it in the daytime to avoid invalidating the experiment. Now our kitchen glowed an eerie red-orange by night. But at least we could cook again.

During my 'dark weeks', I was exposed to an average illuminance of 0.5 lux between 18:00 and midnight and a maximum of 59 lux. That was compared to an average 26 lux (and a maximum of 9640 lux – I have no idea what this super-bright, artificial light source was) when I lived normally – although the actiwatch on my wrist wouldn't have detected any light emitting from my smartphone or laptop during baseline weeks. That's important, because there's mounting evidence to suggest that these devices can disrupt sleep. One 2015 study suggested that using an e-reader before bed prolonged the amount of time it took for people to fall asleep, delayed the circadian clock, suppressed REM sleep, and left participants feeling more tired the next morning, compared to people who read a print book for the same amount of time. Another recent study compared people's responses when they played computer games during the evening on a normal smartphone screen versus one that suppressed blue light. Players felt more alert after using the conventional smartphones and performed worse in cognitive tests the next day, suggesting that their sleep may have suffered. My pledge to avoid artificial light also made socialising difficult. A few days before my experiment started, a friend invited us over to her house for pre-Christmas drinks in the middle of a "dark week". When I explained my predicament, she generously offered to let me sit upstairs in a candle-lit room and receive visitors. I politely declined, feeling how I imagine vegans must feel when they're invited out to a meal at a steakhouse. Instead, we encouraged friends to come to our house, and so they came: amused, curious, and occasionally concerned about what they might find. One family initially declined our invitation to stay for New Year because they were worried their son might knock over the candles. They changed their mind when I told them they could use the lights in their bedroom. (We kept all candles out of kids' reach, just in case.) Once we'd adapted to the challenges, living without artificial light was

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very pleasant. Conversation seemed to flow more easily, and visitors also commented on how mellow and relaxed they felt in the dim light. Another bonus was that our children seemed to settle down more easily in the evenings, although we didn't collect any data on this. But did any of this make any difference to my sleep or mental performance? There was a general trend towards earlier bedtimes during the intervention weeks – particularly during the week when increased daylight was combined with low evening light. On this week, my average bedtime was 23:00, compared to 23:35 on baseline weeks. As it was December, I had a lot of social commitments, so I occasionally ignored my body's sleep signals and stayed up later. It's an issue that researchers often encounter in their studies. "People have social obligations, and it's very hard for them to follow what their clock is telling them to do," says Mariana Figueiro, director of the Lighting Research Centre in Troy, New York. "We are constantly fighting our physiology." Even so, I was significantly sleepier in the evenings during the increased daylight and low evening light intervention weeks. My body also started releasing the darkness hormone, melatonin, some 1.5 hours earlier during the daylight intervention week – and two hours earlier when I avoided evening light. It is a pattern that's been seen in other studies. Like me, Kenneth Wright at the University of Boulder in Colorado has long been fascinated by how our modern lighting environment might be affecting our internal timing. So, in 2013, he sent eight people camping in the Rocky Mountains of Colorado for a week during the summer and measured how this affected their sleep. "Camping is an obvious way of removing ourselves from this modern lighting environment and just getting access to natural light," says Wright. Before the trip, the participants' average bedtime was 00:30 and their wake time 8:00. Both had shifted approximately 1.2 hours earlier by the end of the trip. They also started releasing melatonin some two hours earlier once they were removed from artificial light – although they didn't sleep for any longer. Wright recently repeated the study in winter. This time, he found that participants went to sleep some 2.5 hours earlier under natural lighting conditions but woke up at roughly the same time as when they were living indoors. This meant they slept for around 2.3 hours longer. "We think it's because people were going back to their tents earlier to get warm, so they were giving themselves a longer opportunity to sleep," says Wright. Unlike his participants, I didn't experience a sizeable increase in the amount of sleep I got during the intervention weeks – although there was a slight increase in sleep time and efficiency (the ratio of the total time you spend asleep versus the amount of time bed). However, this didn't reach statistical significance, meaning it could have been the result of chance. Perhaps it was because I was living in a relatively warm house,

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which made defying my body clock easier. I also was forced to get up at the same time each morning by my children – who occasionally woke me at night, too. But when I correlated my sleep with the amount of light I was exposed to during the daytime, an interesting pattern emerged. On the brightest days, I went to bed earlier. And for every 100 lux increase in my average daylight exposure, I experienced an increase in sleep efficiency of almost 1% and got an extra 10 minutes of sleep. I also felt more alert upon waking during all three intervention weeks – but particularly during the two weeks when I was exposed to more daylight. This pattern has been seen in other studies too. The General Services Administration is the largest landlord in the United States. Many of the public buildings it manages either were designed to try and boost indoor daylight levels or have been remodelled, so its leaders were keen to find out if this had made any difference to the health of those working inside them. Working with the Lighting Research Centre's Figueiro, they picked four such office buildings, plus the GSA Regional Office Building in Washington DC – a converted warehouse which had little access to natural daylight at that time. Workers were asked to wear a device that collected light data around their necks, as well as to complete daily mood and sleep questionnaires for a week during summer and again in winter. When the light data started to come in, it was initially disheartening. Despite efforts to boost daylight in the workplace, many GSA workers weren't receiving it. "Our study revealed that if you are three, four, five feet from the window, you lose the daylight," Figueiro says. "It's not just your distance from the window that matters. You have partitions, people pulling the shades. Having a window doesn't necessarily mean you're going to get good daylight." Probing further, Figueiro's team divided the office workers into those who were receiving a high circadian stimulus – light that was bright or blue enough to activate the circadian system – and those who were receiving a low stimulus. Those who received a high stimulus took less time to fall asleep at night and slept for longer. Morning light seemed to be particularly powerful: those exposed to a high stimulus between 8:00 and 12:00 took an average 18 minutes to fall asleep at night, compared to 45 minutes in the low stimulus group. They slept for an extra 20 minutes. Their sleep efficiency was 2.8% higher. And they reported significantly fewer sleep disturbances. These associations were stronger during winter, when people may have had less opportunity to receive natural light during their journey to work. Gordijn also recently published a study which found that people slept better following more exposure to daylight. Here, the participants were wired up to polysomnography monitors to record their sleep-in detail. "People had more deep sleep, and it was less fragmented after more exposure to daylight," Gordijn says.

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Light heart

Until recently, scientists had assumed that our urge to sleep was driven by two independent systems: the circadian system, which affects sleep timing, and a 'homeostatic system' which keeps tabs on how long you've been awake and ratchets up the pressure to sleep. Light was known to alter the timing of sleep via the circadian system. But recent work by Samer Hattar at the University of Maryland has suggested that the light-sensitive cells in the eye, which control the circadian system, also connect to the homeostatic system. "We propose that the timing and intensity of light exposure doesn't only modulate circadian-driven aspects of sleep, but also homeostatic sleep pressure," Gordijn says. Daylight also affects mood. Those GSA office workers who were exposed to brighter morning light scored lower on a self-rated scale of depression. Other research has shown that morning light, as well as light during the day, can improve symptoms of non-seasonal depression. "It probably has to do with being more entrained to the light/dark cycle and sleeping better," says Figueiro. In her study, those who recorded a high circadian stimulus in the daytime tended to be more active during daylight hours and less active once it got dark, suggesting their sleep was more aligned with their internal clock. These data are in accordance with office studies in the UK. In March 2007, Dijk and his colleagues replaced the light bulbs on two floors of an office block in northern England, housing an electronic parts distribution company. Workers on one floor of the building were exposed to blue-enriched lighting for four weeks; those on the other floor were exposed to white light. Then the bulbs were switched, meaning both groups were ultimately exposed to both types of light. They found that exposure to the blue-enriched white light during daytime hours improved the workers' subjective alertness, performance, and evening fatigue. They also reported better quality and longer sleep. This also fits with my own findings. Immediately after waking and before going to bed each night, I filled out a questionnaire to assess how positive and negative I was feeling. The results suggest that my early-morning mood was significantly more positive during the intervention weeks compared to when I was living normally. There was also a trend towards less negative feelings in the evening. And although I didn't officially assess my mood at any other time of day, I felt more energetic and uplifted on those weeks when I spent more time outside. Because of my experience, I'm a convert to outdoor exercise. I'm also learning to embrace the long winter nights: seeing the season as an opportunity to make the house cosy with candles rather than bemoaning the darkness. Even my daughter is a convert. Towards the end of the experiment, I asked her if she was looking forward to switching the

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lights back on. "No," she said. "It has been wonderful, because the candles are really relaxing." Instead, it was my four-year-old son who insisted: he wanted to see what he was eating at dinnertime. Although none of my cognitive test results achieved statistical significance, there was a trend towards faster reaction speeds during the intervention weeks, as well as slightly better performance in a test that involved remembering where a token was hidden in a series of boxes. Studies by Gilles Vanderwalle at the University of Liège in Belgium and Dijk have shown that exposure to bright light activates brain areas involved in alertness – although in these studies, the effects weren't long-lasting. However, in a separate study, researchers at Charité Universitätsmedizin in Berlin discovered that the energising effects of light continued for the rest of the day. When participants were exposed to bright, blue-enriched light in the morning, they reported feeling less sleepy during the evenings, and their reaction speeds were maintained, rather than declining as time wore on. Also, the bright morning light seemed to buffer their body clocks against the effects of blue evening light – a finding which is in accordance with current mathematical models of how light affects the human biological clock and sleep. It supports the idea that brighter and blue-enriched morning light could be a useful countermeasure to artificial light in the evenings especially during the darker seasons, when less daylight is available. It means we don't necessarily need to spend our evenings in darkness or stop using our computers and gadgets. "The effects of light in the evening highly depend on the light you were exposed to in the morning," says Dieter Kunz, who was involved in the study. "When we're talking about kids looking at iPads in the evening, it's having detrimental effects if they're spending their daytimes in biological darkness. But if they're in bright light during the day it may not matter." It's ridiculously simple. But spending more time outdoors during the daytime and dimming the lights in the evening really could be a recipe for better sleep and health. For millennia, humans have lived in synchrony with the Sun. Perhaps it's time we got reacquainted.

BBC Future, 25 April 2018

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

The Exact Cause of Hiccups Is Still a Mystery, But Here's What You Need to Know About a Cure

2018-05-10

Everyone grows up with their own family hiccup cure. There's trying to scare the hiccup victim, holding one's breath, or drinking a glass of

"We don't understand why hiccups come and why they go."

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water upside-down from the far side of the glass. As a kid, my family used the water-drinking technique, which was excellent at making a mess and seemed to be about as good as any other hiccups treatment out there. And actually, that might be the case. That's because there's no single science-backed hiccups treatment, according to Gregory Levitin, an assistant professor of otolaryngology at the Icahn School of Medicine at Mount Sinai Health System. "We don't understand why hiccups come and why they go," Levitin said. "But anything that has a distracting quality would be a positive experience," especially if that distraction provides some other form of stimulation. While scientists don't know the true cause or best treatment for hiccups, they do know what they are. And there are a few strategies Levitin and other otolaryngologists - ear, nose, and throat doctors - recommend for getting hiccups to end and for preventing them in the first place.

The mysterious cause of hiccups

A "hiccup" is the sound we make when we try to breathe in but an involuntary diaphragm spasm causes the vocal chords to snap shut. Doctors technically call this "singultus," a Latin term that refers to sobbing, or gasping while sobbing. Anything that extends the diaphragm or increases distension in the stomach could stimulate a nerve that might cause involuntary spasms, according to Levitin. That includes behaviours like overeating, eating too quickly, or drinking in a way that fills the stomach with air (like consuming carbonated drinks). Babies tend to feed more often than adults and swallow more air when they do, whether they eat from a bottle or breast, so that could explain why they get hiccups more frequently. But what's key is that hiccups stem from an involuntary contraction, a spasm like the ones you might get in a muscle after working out.

A hiccups cure

Though common, hiccups are fortunately an infrequent and self-limiting event for most people, according to Levitin. Still, there are a few things he suggests for people who get the hiccups frequently. "I tell people to take deep breaths and to hold the breaths in between," he said. If the problem is caused by excess air in the stomach, expanding the abdomen may move that air around, allowing some to escape. In a few cases, Levitin said he might try massaging the base of the neck where the phrenic nerve, which stimulates the diaphragm, is located. Sometimes, these methods work - but then again, many supposed hiccup cures seem to work occasionally. "If you do any of these things, it really just passes the time for a few minutes,"

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Levitin said. In rare cases, a case of hiccups can persist for months or even years. In those situations, doctors can try more serious interventions. While there are no medications for hiccups themselves, side effects of other medications might help. Doctors have tried giving people a muscle relaxer or a drug that helps move food through the stomach. Injecting an anaesthetic into the phrenic nerve might provide temporary relief, according to Levitin, though probably only for a few hours. In very severe cases, new options might include battery-powered implants that could stimulate the phrenic nerve. For those patients with real hiccups issues, Levitin said alternative therapies may also provide assistance. Various forms of breath work might help, as could meditation or acupuncture. But when it comes to final answers to the questions of where hiccups come from or how to make them go away, we still don't know. "In the end, we all suffer from the human condition," Levitin said.

Science Alert, 7 May 2018

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

Humans Have a Second Immune System, And It Could Be Ruining Your Dating Life

2018-05-10

About a decade ago, evolutionary psychologists suggested that humans have evolved a first line of defence against disease: this behavioural immune system or BIS. The theory is that perceiving, rightly or wrongly, the threat of disease unconsciously activates this system. Although we cannot see microorganisms with the naked eye, we are nevertheless able to identify cues – such as coughs, unpleasant smells, or skin lesions – that hint at the possible presence of pathogens, whether or not these are actually present or represent real health threats. Scientists have suggested that the activation of the BIS leads to prejudiced and avoidant attitudes and behaviour towards those who display superficial cues connoting disease. But how does this affect our dating lives, where two competing needs are pitted against one another – i.e., the potential benefits of connecting and finding a mate versus the need to protect oneself from disease? McGill University scientists set out to find out, by looking at the activation of the BIS in young, single, heterosexual Montrealers in both real speed-dating events and in experimental online dating. The results were convincing. And not very happy. "We found that when the behavioural immune system was activated it seemed to put the brakes on our drive to connect with our peers socially," says first author of the study Natsumi Sawada, who holds a PhD in psychology from McGill University.

Activating something called the behavioural immune system puts a damper on dating, new research shows.

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"We hadn't expected this to be the case in real life situations like dating where people are generally so motivated to connect. The results suggest that beyond how we consciously or unconsciously think and feel about each other there are additional factors that we may not be consciously aware of, such as a fear of disease that may influence how we connect with others." This video explains how the experiments worked: https://youtu.be/Q_Ks5mj8SXc

The findings appear in the [Personality and Social Psychology Bulletin](#).

Science Alert, 7 May 2018

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

Levitating water droplets with sound waves to improve contaminant detection

2018-05-10

In a new study, researchers showed that using sound waves to levitate droplets of water in midair can improve the detection of harmful heavy metal contaminants such as lead and mercury in water. Detecting small amounts of heavy metals in water is important because these contaminants are harmful to human health and the environment. The new technique could eventually lead to instruments that perform real-time, on-site contaminant monitoring, which could help prevent future lead contamination problems like the Flint, Michigan, water crisis or detect contaminated wastewater from industrial sites. "Despite the large variety of water sensors that offer continual monitoring, detection of multiple heavy metals dissolved in water can only be performed by sending samples off for specialized laboratory analysis," said the research team leader Victor Contreras, from Instituto de Ciencias Físicas UNAM, Mexico. "Our new technique is one step toward the development of a simpler analysis approach that could be applied on-site and in real time. This type of water analysis could be used by agricultural, pharmaceutical, water purification and other industries to monitor water for contaminants." In The Optical Society (OSA) journal *Optics Letters*, the researchers detail their new approach, which uses a sensitive technique known as laser induced breakdown spectroscopy (LIBS) to analyse heavy metals present in levitating drops of water. Levitating the water droplets allows the water to evaporate in a controlled position, which increases the mass concentration of contaminants in the sample and makes it easier to perform LIBS analysis. The researchers showed that their new approach

Researchers showed that using sound waves to levitate droplets of water in midair can improve the detection of harmful heavy metal contaminants such as lead and mercury in water.

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can reliably detect very low levels of the heavy metals like barium, cadmium and mercury with analysis times of just a few minutes.

Using LIBS on liquids

The researchers used LIBS because it offers a fast and straightforward way to identify several elements simultaneously. LIBS works by focusing a high energy laser pulse onto a sample, which vaporizes the material and generates a plasma. Because the light emitted by the plasma contains the atomic fingerprints of the material, it is possible to identify the chemical components of the sample by analysing the emitted light. It is a straightforward process to use LIBS analysis on solid samples. In fact, several commercially available handheld devices are available for this type of analysis. However, it is difficult to use this method to directly analyse liquids because the plasma formed in liquids cools down faster and lasts a very short time. In addition, producing a plasma on a liquid surface produces water splashes that directly affect the spectroscopy reading. With liquid samples, creating a plasma that provides a good signal for chemical detection requires high levels of laser energy, which can only be provided by bulky, non-portable lasers. To circumvent this problem, liquid samples are typically analysed by placing a drop on a substrate and waiting for it to dry in order to concentrate the elements of interest in the sample. Although depositing the sample on a substrate is quite simple, the laser pulse excites atoms from elements in the sample as well as from the substrate. Besides, water evaporation could lead to inhomogeneous distribution of the impurities on the substrate, compromising its signal reproducibility. Instead of depositing the droplets onto a substrate, the researchers used intense sound waves to levitate single droplets of water. The sound waves produce a force strong enough to counteract gravity, allowing a droplet to hover unsupported in the air. "Acoustic levitation is a simple and inexpensive method to preconcentrate the elements of interest while avoiding contamination from the substrate surface," said Contreras. "Moreover, it does not require the sample to have any type of electric or magnetic response like some other methods used to achieve levitation."

Analysing droplets

In the paper, the researchers showed that using acoustic waves to levitate a single drop of water allowed them to detect very low concentrations of heavy metals. For example, they detected 0.7 milligrams per litre of cadmium and 0.2 milligrams per litre of barium. They also showed that the acoustic levitation technique they used is stable enough for reproducible

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LIBS analysis. "This technology has a potential to simultaneously detect heavy metals and other elements in water in a fast and cost-effective way," said Contreras. "An online analyser based on our technology could one day help prevent environmental disasters and contribute to improved water quality control." The researchers are now working to improve the instrumentation. For example, they want to optimise the mechanical design of the acoustic trap to achieve more stable levitation conditions, which will improve the reproducibility of the LIBS readings. They also want to increase the sensitivity by stably levitating smaller drops, which further concentrates the contaminants. This is a key step toward miniaturising the device because it will allow the use of less sensitive, but more compact detectors.

Science Daily, 7 May 2018

<http://www.sciencedaily.com>

Technical Notes

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ENVIRONMENTAL RESEARCH

Sedimentary black carbon and organochlorines in Lesser Himalayan Region of Pakistan: Relationship along the altitude

Estimation of chemical emissions from down-the-drain consumer products using consumer survey data at a country and wastewater treatment plant level

Quantitative determination of acidic hydrolysis products of Chemical Weapons Convention related chemicals from aqueous and soil samples using ion-pair solid phase extraction and in-situ butylation

A contemporary assessment of polybrominated diphenyl ethers (PBDE) in the ambient air and soil of Azerbaijan

Thermolysis of scrap tire and rubber in sub/super-critical water

MEDICAL RESEARCH

Early postnatal exposure to airborne fine particulate matter induces autism-like phenotypes in male rats

Synthesis of nano-cuboidal gold particles for effective antimicrobial property against clinical human pathogens

Divergent hypersensitivity responses following topical application of the quaternary ammonium compound, didecyldimethylammonium bromide

Atropisomers of 2,2',3,3',6,6'-hexachlorobiphenyl (PCB 136) exhibit stereoselective effects on activation of nuclear receptors in vitro

Safety and efficacy of intra-arterial hepatic chemotherapy with doxorubicin-loaded nanoparticles in hepatocellular carcinoma

OCCUPATIONAL RESEARCH

Occupational exposure to indoor air pollution among bakery workers in Ethiopia; A comparison of electric and biomass cookstoves

Pesticides contaminated dust exposure, risk diagnosis and exposure markers in occupational and residential settings of Lahore, Pakistan

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A Pilot Study in Cameroon to Understand Safe Uses of Pesticides in Agriculture, Risk Factors for Farmers' Exposure and Management of Accidental Cases

Genotoxicity assessment of a selected cytostatic drug mixture in human lymphocytes: A study based on concentrations relevant for occupational exposure

The occupational physician's role in the detection and official recognition of occupational skin diseases

PUBLIC HEALTH RESEARCH

Physico-chemical properties of manufactured nanomaterials - Characterisation and relevant methods. An outlook based on the OECD Testing Program

Platinum, palladium, rhodium, molybdenum and strontium in blood of urban women in nine countries

Obesity mediated the association of exposure to polycyclic aromatic hydrocarbon with risk of cardiovascular events

Regulation of chemicals in children's products: How U.S. and EU regulation impacts small markets

Gestational exposure to volatile organic compounds (VOCs) in Northeastern British Columbia, Canada: A pilot study