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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

Taiwan bans PVC in food packaging

2022-05-03

On April 30, 2022, news agency Focus Taiwan reported that Taiwan's Environmental Protection Administration (EPA) will ban food packaging made of or containing any polyvinyl chloride (PVC) beginning July 2023. With the restriction, "Taiwan can expect to reduce some 79 metric tons of PVC food packaging every year." Those caught selling, manufacturing, or importing PVC food packaging may be fined.

Focus Taiwan also reported that the EPA announced new rules to discourage the use of single-use plastic cups. "From July 1, all stores will be required to provide a discount of at least NT\$5 (US\$0.17) to customers with their own cup or face a fine." There has been a smaller government-mandated discount in place since 2011. By January 2023, chain stores must offer reusable cups with a deposit. Moreover, the EPA "has asked local governments to submit their own plans to ban single-use plastic cups and cups made of styrofoam at chain stores by 2024."

Taiwan is following the example of South Korea and New Zealand. South Korea introduced new rules about disposable cups in February 2022, and New Zealand announced in 2021 a plan to ban PVC-containing food packaging by mid-2025 (FPF reported).

Research by Zimmermann et al. in 2021 found that migrates from PVC products, also including food contact materials, were highly toxic in in vitro bioassays (FPF reported). In 2022, Völker et al. reported that of the 34 plastic products tested, PVC and polyurethane products most consistently contained chemicals with adipogenic activity (i.e. fat producing; FPF reported). In addition, according to a framework developed by Senathirajah et al. to characterize and rank the environmental risks of plastic polymers, PVC is one of the polymers with the highest risk of harm (FPF reported).

Read More

Food Packaging Forum, 3-05-22

<https://www.foodpackagingforum.org/news/taiwan-bans-pvc-in-food-packaging>

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Catching up with the rest of the world

2022-05-12

New Zealand generates more than 17 million tonnes of waste each year, and we send almost 13 million tonnes of that to landfill. Our recycling rates are low compared to other countries, and we have too much litter. Of the materials New Zealanders place out for kerbside collection, only about one-third is recycled and composted. Around two-thirds are sent to landfills. In better-performing countries it is the other way around. Another major problem is that too much rubbish goes into recycling bins, and too many recyclables go into rubbish bins. New Zealand households incorrectly dispose of 178,000 tonnes of material at the kerbside each year. 70,000 tonnes of rubbish are placed in recycling bins contaminating the recycling. 108,000 tonnes of recyclables are placed in the rubbish and can't be recycled. We need to make recycling more straightforward and less confusing. This consultation is about improving the way we recycle and recover waste. My goal is to bring our recycling systems up to global standards.

Moving from planning to action

There are three connected initiatives: In the first part, we're proposing a container return scheme. This scheme will encourage people to return their drink containers for recycling in exchange for a small refund. Through a container return scheme, we expect to reduce litter and recover over 85 per cent of eligible containers. The second part addresses our household kerbside recycling collections across New Zealand. A standardised system will improve the quality of what is recycled, reduce recycling costs, and be easier understand. Over time people will also have access to a food scraps bin at kerbside, which will help us reduce our carbon footprint. The third part is about separating business food waste from general waste. Diverting our business food waste away from landfill is needed to both reduce greenhouse gas emissions and make better use of organic material to improve our soil, feed animals, or to produce biogas. I encourage you to have your say and look forward to receiving your input.

Timeframes

This consultation starts on 13 March 2022 and ends at 11:59pm on 22 May 2022. When the consultation period has ended, officials will analyse submissions and provide advice to the Government.

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Read More

New Zealand Ministry of Environment, 12-05-22

<https://images.chemycal.com/Media/Files/Transforming-recycling-consultation-document.pdf>

Australian waterways near heavy road traffic may contain 6PPD

2022-05-12

A substance known to be toxic to aquatic species is likely to be found in Australian waterways “wherever there are significant traffic-related sources”, says the lead author of a study that reported the existence of concentrations of 6PPD-quinone in the country for the first time.

The substance, a transformation product derived from 6PPD, an antioxidant/antiozonant commonly used in the rubber industry, particularly in car tyres, is new to Australian scientists.

The study – Concentrations of tire additive chemicals and tire road wear particles in an Australian urban tributary – was conducted by a team from the University of Queensland’s Alliance for Environmental Health Sciences (QAEHS) and published in January.

Research in the US indicates that n-(1,3-dimethylbutyl)-n’-phenyl-1,4-benzenediamine (6PPD), used as an anti-wear compound in tyres, gives rise to 6PPD-quinone, which could wash into streams during storms.

The scientists carried out tests at a tributary of the Brisbane River in 2020 during June and October storm events. In every sample taken, 6PPD-quinone was detected at levels comparable to those linked with coho salmon deaths reported by research projects in the US and Canada last year.

Lead author Cassandra Rauert, a research fellow at the QAEHS, said that this is the first time the substance has been reported in Australian waterways.

“While 6PPD-quinone concentrations in this catchment were lower than previous [overseas] studies, elevated concentrations post storm suggest prolonged aquatic exposure,” said Dr Rauert.

Potential risk

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“As yet there have been no toxicity studies on vulnerable Australian aquatic life, so we don’t know the potential risk here,” added Dr Rauert. “We still don’t know the full extent of the toxicity of 6PPD-quinone, especially towards Australian species.”

The team will conduct further surveys to ascertain concentrations in different regions of the country and in varying circumstances to understand environmental exposure. It is also working with groups in Europe and the UK investigating leachates from tyre crumb.

“We are not undertaking ecotoxicity studies but there may be other groups in Australia currently looking at vulnerable species,” she said.

A spokesperson from the Department of Agriculture, Water and the Environment (DAWE) told Chemical Watch: “We are not aware of any evidence of toxic effects of 6PPD-quinone on aquatic life in Australia,” adding that it will continue to closely monitor emerging research for any new information on how it may affect aquatic life.

Read More

Chemical Watch, 12-05-22

<https://chemicalwatch.com/480972/australian-waterways-near-heavy-road-traffic-may-contain-6ppd>

AMERICA

EPA Research Team Develops Framework to Determine What Products to Classify and Evaluate as Nanopesticides

2022-05-10

According to a May 9, 2022, news item published by the U.S. Environmental Protection Agency (EPA), “Advancing EPA’s Understanding of the Next Generation of Pesticides,” over the past decade, EPA “has received an increasing number of pesticide product applications that potentially contain nanomaterials.” The article notes that EPA’s current pesticide review method was not designed for nanomaterials, so each product is reviewed on a case-by-case basis. An EPA research team led by EPA scientist Dr. Chunming Su conducted an exhaustive search for patents and published literature related to nanopesticides to understand the state of the science. The item states that the team found and analyzed more

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than 36,000 patents and 500 peer-reviewed journal articles. The team established two general categories of nanopesticides to help inform EPA's regulatory reviews: products with mostly metal-based nanomaterials as the active ingredient, like nanosilver and nanocopper oxide/hydroxide; and products that encapsulate and carry the active ingredient using nanomaterials (mostly carbon based) like graphene and carbon nanotubes. According to the item, the research team also developed a review framework "that includes a simple decision tree to determine what products should be classified and evaluated as a nanopesticide." Products determined to contain nanomaterials are subject to additional assessment or data needs from the manufacturer. Dr. Andrew Byro of EPA's Office of Pesticide Programs (OPP) states that the framework "represents a major steppingstone in the development of a method for identification of nanomaterials." EPA will use this framework as a platform to help inform its data needs and future determinations regarding the evaluation of nanomaterials in antimicrobial pesticides.

Read More

Nano and Other Emerging Chemical Technologies Blog, 10-05-22

<https://nanotech.lawbc.com/2022/05/epa-research-team-develops-framework-to-determine-what-products-to-classify-and-evaluate-as-nanopesticides/>

It's time for Congress to ban toxic 'forever chemicals' from food packaging

2022-05-11

The next time you order takeout at a favorite restaurant, there is a decent chance it will include a side order of toxic forever chemicals. That's because many popular chain restaurants wrap their food in packaging made with PFAS, a dangerous class of chemicals that have been linked to an increased risk for some cancers, lower birth weight and immune system suppression.

PFAS are sometimes called "forever chemicals" because they are resistant to breaking down naturally in the environment, and can remain in people's bodies for years. In fact, a recent peer-reviewed study by Toxic Free Future and the University of Washington found PFAS in every sample of breast-milk from fifty mothers in the Seattle area.

Unfortunately, PFAS from food wrappers contaminates water in the communities where it is produced, can seep into the food we eat, and pollute soil and water when packaging is disposed of in a landfill. While

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the packaging may be used once, the chemicals can last forever in the environment and make their way into our bodies.

Over the past few years, Toxic-Free Future conducted several studies on PFAS in food packaging and led a campaign to convince chain restaurants and grocery stores to stop using packaging made with PFAS that has won commitments from more than twenty corporations to phase out their use.

Read More

Food Safety News, 11-05-22

<https://www.foodsafetynews.com/2022/05/its-time-for-congress-to-ban-toxic-forever-chemicals-from-food-packaging/>

20 million acres of U.S. cropland may be contaminated by PFAS 'forever chemicals'

2022-05-11

Toxic per- and polyfluorinated alkyl substances, known as PFAS or "forever chemicals," are a family of more than 9,000 synthetic, human-made chemicals that barely break down in the natural environment, according to CHEM Trust. PFAS are used to make products water-, heat- or stain-resistant, The Guardian reported. Very low amounts of these forever chemicals in drinking water have been linked to a higher risk of cancer, immunosuppression, interference with the reproductive system and other health problems, according to the Environmental Working Group (EWG).

Forever chemicals are found in thousands of products, from disposable and fast-food packaging to popcorn bags, takeout containers, pre-made cakes, pizza boxes and products like nonstick cookware, carpets, waterproof clothing, sunscreen, cosmetics and mattresses, CHEM Trust reported. PFAS have been detected in wildlife and people all over the world.

Almost all Americans have PFAS in their blood, reported EWG. Since the chemicals don't break down naturally, they often end up in the sewer system. Now, a new EWG report estimates that around 20 million acres of U.S. cropland could be contaminated by sewage sludge tainted by these forever chemicals.

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[Read More](#)

Nation of Change, 11-05-22

<https://www.nationofchange.org/2022/05/10/20-million-acres-of-u-s-cropland-may-be-contaminated-by-pfas-forever-chemicals/>

MassDEP Commemorates National Drinking Water Week by Awarding Commendations to 39 Public Water Systems and Operators

2022-05-10

In honor of National Drinking Water Week, the Massachusetts Department of Environmental Protection (MassDEP) today announced that 39 public water systems across the Commonwealth have received awards of commendation for their noteworthy public service delivered during 2021. The criteria MassDEP uses include excellent water service to the public, no violations or non-compliance issues, and efforts that support public water supply services, such as source-water protection, water quality, and conservation.

“Public water systems across the Commonwealth do a great job ensuring there is access to safe, healthy drinking water, but each year, there are some systems that stand out and deserve special recognition,” said MassDEP Commissioner Martin Suuberg. “Today, the Baker-Polito Administration is honored to recognize these exceptional water systems and operators for their distinguished work protecting the health of their communities during this year’s National Drinking Water Week.”

MassDEP works with drinking water utilities to make sure that the water delivered to consumers meets all federal and state standards and is clean and abundant, and each of the systems recognized have complete compliance with the regulations for calendar year 2021. For more than 35 years, during National Drinking Water Week in May, MassDEP has recognized and awarded certain exemplary systems that have reached meritorious service for their work during the previous calendar year. This year’s public ceremony was held at the Devens Common Center in Devens.

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[Read More](#)

Massachusetts Department of Environmental Protection, 10-05-22

https://www.einnews.com/pr_news/571865142/massdep-commemorates-national-drinking-water-week-by-awarding-commendations-to-39-public-water-systems-and-operators

EUROPE

European Commission Includes PFAS In Its Ambitious “Restrictions Roadmap”

2022-05-10

Back in October 2020, the European Commission (EC) issued its Chemicals Strategy for Sustainability to achieve a “toxic-free environment” as part the European Green Deal. On April 25, 2022, EC staff released a Restrictions Roadmap, which outlines objectives for regulating broad categories of chemicals through collaboration between EC, European Chemicals Agency, and member states. The Roadmap prioritizes specific chemical groups for further regulation, with the highest priority chemical groups added to a “Rolling List.” PFAS chemicals as a group have been included on this Rolling List after several member states determined that this class of chemicals is confirmed or suspected to be hazardous as: (i) persistent, bioaccumulative, and toxic; (ii) very persistent and very bioaccumulative; (iii) persistent, mobile, and toxic; and (iv) reproductively toxic. EC’s staff’s announced goal is to invite comment and input on the chemicals on the Rolling List with an eye towards eventually updating the EC’s Reach Regulation to address the proposed new approaches to chemical regulations by 2027.

[Read More](#)

JD Supra, 10-05-22

<https://www.jdsupra.com/legalnews/european-commission-includes-pfas-in-1239203/>

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EFSA CEP Panel updates from November 2021 to April 2022

2022-05-11

The European Food Safety Authority (EFSA) Panel on Food Contact Materials, Enzymes and Processing Aids (CEP Panel) published the minutes of the 26th to 28th meetings of its Working Group on Food Contact Materials (WG-FCM) held in November 2021 and January and April 2022. The panel reviews draft opinions on new food contact materials and chemicals at each meeting, as well as how applications submitted to EFSA will be reviewed after implementation of the transparency regulation. The most recent meeting also discussed the safety assessment of compounds and mixtures of natural origin.

Furthermore, the EFSA CEP Panel published the minutes of the 61st through 65th meetings of its Working Group on bisphenol A (BPA, CAS 80-05-7) re-evaluation (WG-BPA) held from late October 2021 to early April 2022. Work within the WG-BPA concerns the “re-evaluation of the risks to public health related to the presence of BPA in foodstuffs and protocol for the risk assessment strategy.” Meetings in late 2021 continued the discussion on genotoxicity. The working group held a break-out session with genotoxicity experts to address the methodology for performing uncertainty analysis which was approved at the next meeting by the WG-BPA.

The WG-BPA published the draft results of the BPA re-evaluation in December 2021. The CEP Panel suggested lowering the amount of BPA considered safe to be “ingested daily over a lifetime without appreciable risk,” from 4 µg/kg body weight/day to 0.00004 µg/kg body weight/day (FPF reported). In January, the WG-BPA held a technical meeting for stakeholders to discuss the opinion (FPF reported). The two subsequent meetings of the WG-BPA were primarily dedicated to reviewing the feedback received from stakeholders in January.

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Food Packaging Forum, 11-05-22

<https://www.foodpackagingforum.org/news/efsa-cep-panel-updates-from-november-2021-to-april-2022>

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The chemicals that linger for decades in your blood

2022-05-13

Environmental journalist Anna Turns experienced a wake-up call when she had her blood tested for toxic synthetic chemicals – and discovered that some contaminants persist for decades.

In March 2022, scientists confirmed they had found microplastics in human blood for the first time. These tiny fragments were in 80% of the 22 people tested – who were ordinary, anonymous members of the public. The sample size was small and as yet there has been no explicit confirmation that their presence causes any direct harm to human health, but with more research, time will tell.

Microplastics are the subject of a lot of scrutiny. Wherever we look for them we find them. And yet, there are perhaps other less tangible pollutants that should be hitting the headlines, and which have been in our blood for decades.

Chemical pollution has officially crossed “a planetary boundary”, threatening the Earth’s systems just as climate change and habitat loss are known to do. A recent study by scientists from Sweden, the UK, Canada, Denmark and Switzerland highlights the urgent need to turn off the tap at source. Many toxic chemicals, known as persistent organic pollutants, or POPs, don’t easily degrade. They can linger in the environment and inside us – mostly in our blood and fatty tissues – for many years.

I was curious about whether any of these chemicals were in my own blood while researching for my book, *Go Toxic Free: Easy and Sustainable Ways to Reduce Chemical Pollution*, I contacted a professor of environmental chemistry in Norway called Bert van Bavel. His research has focused on POPs that persist in bodies for more than 20, 30, sometimes 50 years and he analyses how high exposure in populations correlates to cancers, heart disease and conditions such as diabetes.

Bert van Bavel developed a blood test protocol for Safe Planet, a global awareness campaign established by the UN Environmental Programme that could be used to monitor the levels of these toxic chemicals in the global population.

Safe Planet highlights the harm caused by the production, use and disposal of hazardous chemicals such as flame retardants and pesticides, many of which have been banned. He designed a test to measure ‘body burden’ – that’s the amount of these persistent synthetic chemical

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pollutants that accumulate in the body. Since 2010, this test has been carried out on more than 100,000 people around the world, across Europe, North and South America, Africa and Southern Asia.

Now, it was my turn. I booked an appointment at my local GP surgery and had my blood taken. I carefully packaged up the test tubes and couriered them to a specialist lab in Norway which spent six weeks analysing my blood for 100 or so POPs in line with this body burden test protocol.

Read More

BBC, 13-05-22

<https://www.bbc.com/future/article/20220512-the-chemicals-that-linger-for-decades-in-your-blood>

INTERNATIONAL

New US & European regulations will affect the semiconductor industry

2022-05-10

In March, the US 3M Company stopped operating its PFAS (perfluoro/polyfluoroalkyl compound) refrigerant plant in Belgium. This attracted the attention of the semiconductor industry because PFAS has important applications in lithography and etching processes. However, there are reports that stopping production is only the beginning of new environmental laws. These new environmental protection regulations are emanating from Europe and the United States.

European countries are trying to comprehensively restrict the manufacture, use and export of PFAS in 2025. However, the industry has concerns and is uncertain that there will be alternative products. If there is none, then this will lead to a long-term shortage of relevant semiconductor materials.

The report also predicts that environmental regulations in Asia will be gradually strengthened in the future. Semiconductor manufacturers should take precautions and reserve alternative sources or alternative technologies in advance.

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Gizchina, 10-05-22

<https://www.gizchina.com/2022/05/10/new-us-european-regulations-will-affect-the-semiconductor-industry/>

Google, UN Partner to Fight Misinformation on Climate Change

2022-05-02

For Google, the search features are part of a larger push to build products and tools that empower people to better understand and limit their personal environmental impact — and highlights verified sources of climate data in 12 languages.

Google and the United Nations have partnered to ensure that when people google “climate change,” they’re presented with a variety of verified, authoritative sources of information in 12 languages. In addition to organic search results, Google is surfacing short and easy-to-understand information panels and visuals on the causes and effects of climate change, as well as individual actions that people can take to help tackle the climate crisis.

“We are happy to collaborate with Google to ensure that factual, trustworthy content about climate change is available to as wide a global audience as possible,” said Melissa Fleming, United Nations Under-Secretary-General for Global Communications. “Misinformation is so widespread these days that it threatens progress and understanding on many critical issues, including climate. The need for accurate, science-based information on a subject like climate change to rise to the top of searches has therefore never been greater.”

In his 2021 report, Our Common Agenda, United Nations Secretary-General António Guterres called for tackling the “infodemic” of misinformation plaguing the world and proposed introducing a global code of conduct that promotes integrity in public information and facts and science in public discourse.

For Google, the search features are part of a larger push to build products and tools that empower people to better understand and limit their personal environmental impact — adding to a growing arsenal of

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educational tools that help employees and consumers do their part to rein in their carbon footprint in a variety of areas.

[Read More](#)

Sustainable Brands, 2-05-22

<https://sustainablebrands.com/read/marketing-and-comms/google-un-partner-to-fight-misinformation-on-climate-change/>

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REACH Update

MAY. 20, 2022

Resorcinol SVHC identification faces U-turn after 'misinterpreted' vote outcome

2022-05-13

The European Commission has been forced to make a U-turn on its controversial decision to identify resorcinol as an SVHC after finding that it had misinterpreted the outcome of a vote by EU member states, which had delivered a split verdict and not an endorsement of the draft Regulation as initially understood.

According to Commission sources, the EU executive is rethinking the way forward for its intention to add the endocrine disrupting chemical to the REACH candidate list. It had declared victory over the issue in February after a long battle with industry and some member states that disputed the scientific evidence behind the move.

The vote by the REACH Committee, finalised in January through a written procedure, was deemed "positive" even though those in favour – 19 countries – represented 54% of the EU's population, short of the 65% threshold required for a qualified majority vote.

It was passed on the basis that only three member states were against, fewer than the minimum four that constitute a 'blocking minority' under Article 16 of the Treaty on European Union (TEU).

The Commission subsequently corrected the voting outcome to "no opinion" after it received legal advice that it had misinterpreted the applicable voting rules, the sources said. An industry task force had also questioned the Commission's initial judgement of the outcome.

The substance – a high-volume compound used to make tyres, rubber products, adhesives and industrial resins, as well as some cosmetics and medical products – is the first to be identified as an SVHC because of its thyroid-disrupting effects in humans.

[Read More](#)

Chemical Watch, 13-05-22

<https://chemicalwatch.com/481989/resorcinol-svhc-identification-faces-u-turn-after-misinterpreted-vote-outcome>

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REACH Update

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HSE has proposed a restriction on hazardous substances present in tattoo inks and PMU

2022-05-06

HSE has proposed a restriction on hazardous substances present in tattoo inks and PMU as a precautionary measure to address potential risks to human health, as there is currently no legislation in GB that addresses the risks presented by insertion into the skin of these substances.

On 29 April 2021, the Health and Safety Executive (HSE) as the Agency for UK REACH (referred to as the Agency hereafter) received a request under Article 69(1) of UK REACH from the Defra Secretary of State, with the consent of the Scottish Government and the Welsh Government, to prepare an Annex 15 restriction dossier assessing the risks to humans from substances in tattoo ink and permanent make up (PMU). As of 4 January 2022, the European Union (EU) has restricted the presence of over 4000 potentially harmful substances in these preparations. This dossier examines whether a similar restriction should be introduced into Great Britain (GB)³. In the request, DEFRA asked the Agency to include in this dossier all substances listed in Council of Europe resolution

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HSE, 6-05-22

https://consultations.hse.gov.uk/crd-reach/restriction-proposals-003/supporting_documents/Annex%2015%20restriction%20dossier%20%20tattoo%20inks.pdf

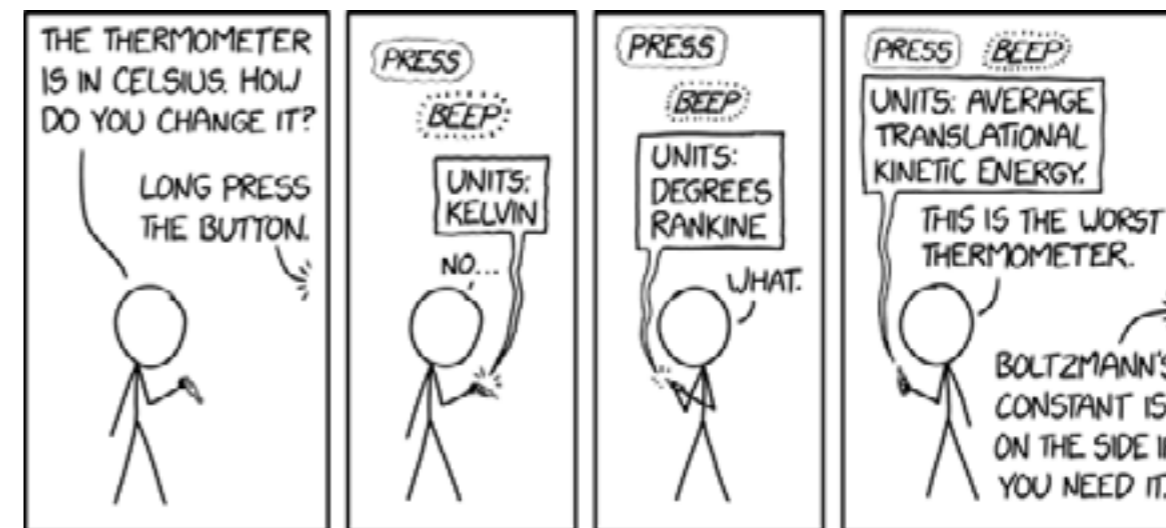
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<https://xkcd.com/2292/>

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Hazard Alert

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Bromoform

2022-05-20

Bromoform (CHBr_3) is a pale yellowish liquid with a sweet odour similar to chloroform. It is soluble in about 800 parts water and is miscible with alcohol, benzene, chloroform, ether, petroleum ether, acetone, and oils. It is also non-flammable and readily evaporates into the air. Bromoform is produced naturally by phytoplankton and seaweeds in the ocean and this is thought to be the predominant source to the environment. However, locally significant amounts of bromoform enter the environment formed as disinfection by-products known as the trihalomethanes when chlorine is added to drinking water to kill bacteria. [1,2]

USES [3]

Bromoform is used as an intermediate in geological assaying and as a solvent for waxes, greases, and oils. It is also used in shipbuilding, aircraft, and aerospace industries and as an ingredient in fire-resistant chemicals and gauge fluid. Traces of bromoform are likely to be present in swimming pools, municipal waters, and wastes as a result of chlorination in the presence of naturally occurring bromide ions and humic substances. It is hypothesised that bromoform may be formed by the haloform reaction which occurs during the chlorination of water.

SOURCES & ROUTES OF EXPOSURE [2, 4]

Studies have indicated that bromoform can easily enter the body after swallowing them in water or breathing them in air. In addition, they can enter the body through the skin (for example, by washing or showering in water containing these chemicals). Some portion of bromoform entering the body may be broken down to other compounds. Bromoform and its breakdown products can be removed from the body by being exhaled from the lungs. These chemicals leave the body fairly rapidly. Bromoform does not tend to build up in the body; 50-90% of the amount that enters the body is removed within 8 hours. The principal route of human exposure to bromoform is from drinking water that has been disinfected with chlorine, bromine, or bromine compounds. Bromoform has been detected in swimming pools that have been disinfected with bromine or bromine compounds; therefore, exposure to low levels could occur from inhalation of bromoform that has evaporated into the air or through the skin from bromoform in the water. In addition, exposure could also occur from inhalation of ambient air near factories or laboratories that

Bromoform (CHBr_3) is a pale yellowish liquid with a sweet odour similar to chloroform.

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use bromoform. Another place for exposure is near a chemical waste site where bromoform leaked into water or soil.

HEALTH EFFECTS [2]

Acute Effects

Human exposure to large amounts of bromoform through inhalation and oral exposure can result in unconsciousness. Animal studies, combined with limited observations in humans, indicate that the principal adverse health effects associated with short-term inhalation or oral exposure to high levels of bromoform are CNS depression, resulting in the slowing down of normal brain activities, sedation, narcosis, and sleep, and liver and kidney injury.

Chronic Effects

The long-term effects of exposure to bromoform in humans have not been studied. Animal studies indicate effects on the liver, kidney, and CNS from chronic oral exposure to bromoform. The Reference Dose (RfD) for bromoform is 0.02 milligrams per kilogram body weight per day (mg/kg/d) based on hepatic lesions in rats. The United States Environmental Protection Agency has determined that there are insufficient data to calculate a Reference Concentration (RfC) for bromoform.

Cancer Risk

The only available human cancer study suggested a positive correlation between levels of bromoform in drinking water and the incidence of several tumour types. However, this study was considered to be incomplete and preliminary because the study design did not permit consideration of variables such as personal habits, residential histories, and past exposures. Animal studies have demonstrated an increase in the incidences of liver and intestinal tumours following oral exposure to bromoform. EPA considers bromoform to be a probable human carcinogen and has ranked it in EPA's Group B2.

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

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open. Cold water may be used. WARM water MUST be used. 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 immediate medical attention.
- Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
- 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. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Exposure Control & Personal Protection

Engineering Controls

Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value.

Personal Protection Equipment

- 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 (A self contained breathing apparatus should be used to avoid inhalation of the product);

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- Boots;
- Gloves;

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

REGULATION

United States

OSHA: The Occupational Safety & Health Administration has set the following Permissible Exposure Limit (PEL) for bromoform:

- General Industry: 29 CFR 1910.1000 Table Z-1 - 0.5 ppm, 5 mg/m³ TWA; Skin
- Construction Industry: 29 CFR 1926.55 Appendix A - 0.5 ppm, 5 mg/m³ TWA; Skin
- Maritime: 29 CFR 1915.1000 Table Z-Shipyards - 0.5 ppm, 5 mg/m³ TWA; Skin

ACGIH: American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for bromoform of 0.5 ppm, 5.2 mg/m³ TWA; Skin; Appendix A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans

NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) for bromoform of 0.5 ppm, 5.2 mg/m³ TWA; Skin

Australia [7]

Safe Work Australia: Safe Work Australia has set a time weighted average concentration (TWA) for bromoform of 0.5ppm or 5.2mg/m³ for a 40 hour work week.

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The US FDA has moved to ban menthol cigarettes. Australia should do that and more

2022-05-09

Menthol is the minty cigarette ingredient that conjures up images of beaches, snow-covered ski slopes and glamorous yacht parties, all crisp white and fresh green. Menthol as a deadly additive is under threat at last.

Several countries, including Canada, Ethiopia, Turkey, Chile, the European Union and the United Kingdom, have banned the use of menthol and other flavours in tobacco products.

Late to regulating menthol in tobacco products, the US Food and Drug Administration has also announced a ban.

In Australia, we have done little to change what's inside cigarettes and other smoking products. So we lag even further behind the many other countries that have banned menthol.

For 'timid' ladies

The marketing of menthol by the tobacco industry in Australia has long been targeted at supposedly sophisticated smokers. In Melbourne in the 1990s, tobacco giant Philip Morris – in its personality analysis of smokers of its Alpine menthol brand – found the “Alpine Gal is a physically timid lady”, so the packaging had to be “gentle”, not “dare devil”.

More recently, the industry added menthol “crush balls” or capsules in filters in Australian cigarettes, so users get a burst of menthol by biting on the filter. Once again, women and children are the target market. A study from Wales showed the fact that:

[...] three in five 11–16 year-old smokers reported using menthol cigarettes in the past 30 days highlights how appealing these products are to young people, particularly capsule cigarettes, used by 70% of menthol smokers.

A search of millions of tobacco industry documents confirms menthol is designed to attract new young smokers, who incorrectly believe it makes cigarettes somehow less harmful.

In 2012, Australia's then health minister and Attorney-General Nicola Roxon regulated the outside of cigarette packets, introducing plain packaging with graphic health warnings. Although significant, the packaging change did nothing to alter what was inside the product.

A search of millions of tobacco industry documents confirms menthol is designed to attract new young smokers, who incorrectly believe it makes cigarettes somehow less harmful.

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Nor have subsequent governments.

In other words, we have not yet regulated the most damaging aspects of cigarette design that increase and maintain addiction.

Not really 'light' - just dangerous

Menthol is associated with so-called "light" cigarettes, which the Australian Competition and Consumer Commission (ACCC) has found misleading and deceptive and banned the use of the term. The ACCC did not ban the content or engineering of cigarettes.

It is not just additives in cigarettes, and the smoke emissions, that are harmful. The "engineering hoax" of filters – which don't make smoking any safer – is an even more dangerous fraud.

A new era of additives

Australia's new National Tobacco Strategy Consultation Draft says it will "explore" regulation of filters, additives – including menthol – and nicotine content, but offers little certainty.

In the UK, the ban on menthol cigarettes not only triggered a switch to menthol vapes, but also prompted the tobacco industry to invent new products to exploit loopholes in the law.

Late last year, the Organised Crime and Corruption Reporting Project – a network of investigative journalists – found:

"A key goal of Big Tobacco was to get menthol defined as vaguely as possible."

So, any attempts at legislative control must be tightly worded. Big tobacco will drive its legal trucks through anything vague.

The effects of bans are mixed

Canadian research showed a fall in smoking rates followed their menthol ban.

Other research suggested targeting menthol in cigarettes might cause a switch to vaping, as in the UK. We know that vaping is a global public health problem and that flavourings drive uptake in adolescents. The FDA will not immediately ban menthol in e-cigarettes.

Vaping causes lung damage and exacerbates COVID symptoms.

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E-cigarettes and heat-not-burn products should be regulated in exactly the same way as other tobacco products, and flavours should be regulated or eliminated.

New Zealand has moved to reduce nicotine content, the principal addictive drug in tobacco. But NZ has dropped the ball on e-cigarettes by separating its regulatory framework from other tobacco products. The country is experiencing high rates of teenage vaping uptake.

Smoking kills

There are three million smokers in Australia. Two-thirds will die from smoking-related diseases.

Most will have health problems, and our hospital emergency departments and wards deal with much higher rates of smokers being admitted than the general population.

The crushing burden on the health system and the associated economic cost could be effectively reduced with comprehensive regulatory measures on tobacco.

Endgame

The four endgame initiatives that will reduce smoking and vaping to a minimum in Australia are:

1. a ban on sales of both combustible and vape tobacco products to anyone born after the year 2004
2. regulation to eliminate flavours (including, but not limited to, menthol) in combustible, vape and emerging tobacco products
3. staged reduction in nicotine content
4. a ban on filter ventilation engineering in cigarettes.

Banning menthol as a standalone reform would make a modest contribution to reducing smoking and vaping rates in Australia.

However, substantive reduction in smoking rates will only occur with a comprehensive suite of measures, already strongly supported in the community. These include phasing out the sale of tobacco products completely.

The Conversation, 9 May 2022

<https://theconversation.com>

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Mercury removal made easy in toxic environments

2022-05-13

Mercury pollution is a global problem in water, air and soil near goldmines, cement and some metal production, and other heavy industries burning fossil fuels—with removal too expensive or difficult in some of the poorest countries in the world.

Now Flinders University experts have expanded testing of a sustainable extraction material capable of absorbing almost all mercury in polluted water in minutes—itsself made entirely from low-cost waste from the petroleum, citrus and agricultural production.

In fact, the tests showed almost total absorption of mercury within minutes in trial conditions, says senior author Professor Justin Chalker and fellow scientists in a new journal article published by the Royal Society of Chemistry

“It is clear from the study that this mercury-binding material, invented at Flinders University, is ultra-fast in its ability to remove mercury from water. In some cases, more than 99% of the mercury is captured in just a few minutes,” says Professor Chalker.

Chalker Lab co-author Dr. Max Worthington says testing was done on a new material created by coating silica with sulfur and limonene—a novel chemical combination already shown to effectively absorb waste mercury.

“This silica covered with an ultra-thin coating of poly(S-r-limonene), using sulfur left over in petroleum production and orange oil from orange peel discarded by the citrus industry, was extensively tested in various pH and salt concentrations,” he says.

“Not only is this new mercury sorbent able to rapidly bind to mercury in water, but is also selective in taking up mercury but not other metal contaminants such as iron, copper, cadmium, lead, zinc and aluminum.”

Importantly this means that only mercury will bind to the orange-sulfur sorbent, which helps with safety after capturing the inorganic mercury, adds co-author Dr. Max Mann from the Flinders University Chalker Lab.

“The particles contained in just 27g of this free-flowing orange powder has an approximate surface area of a soccer field, and it can be quickly produced in large enough volumes to suit contamination levels,” he says.

Flinders University experts have expanded testing of a sustainable extraction material capable of absorbing almost all mercury in polluted water in minutes

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Chalker Lab Ph.D. candidate Alfrets Tikoalu says silica sourced from agricultural waste, such as wheat or rice production, could also be used for the material to be made even more sustainable.

“This mercury remediation technology can be a circular economy solution for a more sustainable world because this value-added material is made entirely from waste,” he says.

To shore up the findings, mathematical modeling was used to qualitatively understand the rate of mercury uptake—data critical to measuring and optimizing the new sorbent in real-world remediation.

“This is an exciting new development in producing renewable and accessible solutions to major environmental issues facing the world today,” says applied mathematician Dr. Tony Miller, another co-author of the publication in Physical Chemistry Chemistry Physics.

The project is an “excellent example of collaboration across chemical and physical sciences and mathematics to understand the rate of mercury uptake by our new and innovative sorbent,” Professor Chalker says.

The article, “Modeling mercury sorption of a polysulfide coating made from sulfur and limonene,” has been published in Physical Chemistry Chemistry Physics.

Phys Org, 13 May 2022

<https://phys.org>

Global pollution kills 9 million people a year, study finds

2022-05-18

A new study blames pollution of all types for 9 million deaths a year globally, with the death toll attributed to dirty air from cars, trucks and industry rising 55% since 2000.

That increase is offset by fewer pollution deaths from primitive indoor stoves and water contaminated with human and animal waste, so overall pollution deaths in 2019 are about the same as 2015.

The United States is the only fully industrialized country in the top 10 nations for total pollution deaths, ranking 7th with 142,883 deaths blamed on pollution in 2019, sandwiched between Bangladesh and Ethiopia, according to a new study in the journal The Lancet Planetary Health.

Pollution kills about the same number of people a year around the world as cigarette smoking and second-hand smoke combined, the study said.

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Tuesday's pre-pandemic study is based on calculations derived from the Global Burden of Disease database and the Institute for Health Metrics and Evaluation in Seattle. India and China lead the world in pollution deaths with nearly 2.4 million and almost 2.2 million deaths a year, but the two nations also have the world's largest populations.

When deaths are put on a per population rate, the United States ranks 31st from the bottom at 43.6 pollution deaths per 100,000. Chad and the Central African Republic rank the highest with rates about 300 pollution deaths per 100,000, more than half of them due to tainted water, while Brunei, Qatar and Iceland have the lowest pollution death rates ranging from 15 to 23. The global average is 117 pollution deaths per 100,000 people.

Pollution kills about the same number of people a year around the world as cigarette smoking and second-hand smoke combined, the study said.

"9 million deaths is a lot of deaths," said Philip Landrigan, director of the Global Public Health Program and Global Pollution Observatory at Boston College.

"The bad news is that it's not decreasing," Landrigan said. "We're making gains in the easy stuff and we're seeing the more difficult stuff, which is the ambient (outdoor industrial) air pollution and the chemical pollution, still going up."

It doesn't have to be this way, researchers said.

"They are preventable deaths. Each and every one of them is a death that is unnecessary," said Dr. Lynn Goldman, dean of the George Washington University School of Public Health, who wasn't part of the study. She said the calculations made sense and if anything, was so conservative about what it attributed to pollution, that the real death toll is likely higher.

The certificates for these deaths don't say pollution. They list heart disease, stroke, lung cancer, other lung issues and diabetes that are "tightly correlated" with pollution by numerous epidemiological studies, Landrigan said. To then put these together with actual deaths, researchers look at the number of deaths by cause, exposure to pollution weighted for various factors, and then complicated exposure response calculations derived by large epidemiological studies based on thousands of people over decades of study, he said. It's the same way scientists can say cigarettes cause cancer and heart disease deaths.

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"That cannon of information constitutes causality," Landrigan said. "That's how we do it."

Five outside experts in public health and air pollution, including Goldman, told The Associated Press the study follows mainstream scientific thought. Dr. Renee Salas, an emergency room doctor and Harvard professor who wasn't part of the study, said "the American Heart Association determined over a decade ago that exposure to (tiny pollution particles) like that generated from the burning of fossil fuels is causal for heart disease and death."

"While people focus on decreasing their blood pressure and cholesterol, few recognize that the removal of air pollution is an important prescription to improve their heart health," Salas said.

Three-quarters of the overall pollution deaths came from air pollution and the overwhelming part of that is "a combination of pollution from stationary sources like coal-fired power plants and steel mills on one hand and mobile sources like cars, trucks and buses. And it's just a big global problem," said Landrigan, a public health physician. "And it's getting worse around the world as countries develop and cities grow."

In New Delhi, India, air pollution peaks in the winter months and last year the city saw just two days when the air wasn't considered polluted. It was the first time in four years that the city experienced a clean air day during the winter months.

That air pollution remains the leading cause of death in South Asia reconfirms what is already known, but the increase in these deaths means that toxic emissions from vehicles and energy generation is increasing, said Anumita Roychowdhury, a director at the advocacy group Centre for Science and Environment in New Delhi.

Smoke and steam rise from a coal processing plant in Hejin in central China's Shanxi Province on Nov. 28, 2019. A study released on Tuesday, May 17, 2022, blames pollution of all types for 9 million deaths a year globally, with the death toll attributed to dirty air from cars, trucks and industry rising 55% since 2000. Credit: AP Photo/Sam McNeil, File

"This data is a reminder of what is going wrong but also that it is an opportunity to fix it," Roychowdhury said.

Pollution deaths are soaring in the poorest areas, experts said.

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“This problem is worst in areas of the world where population is most dense (e.g. Asia) and where financial and government resources to address the pollution problem are limited and stretched thin to address a host of challenges including health care availability and diet as well as pollution,” said Dan Greenbaum, president of the Health Effects Institute, who wasn’t part of the study.

In 2000, industrial air pollution killed about 2.9 million people a year globally. By 2015 it was up to 4.2 million and in 2019 it was 4.5 million, the study said. Toss in household air pollution, mostly from inefficient primitive stoves, and air pollution killed 6.7 million people in 2019, the study found.

Lead pollution—some from lead additive which has been banned from gasoline in every country in the world and also from old paint, recycling batteries and other manufacturing—kills 900,000 people a year, while water pollution is responsible for 1.4 million deaths a year. Occupational health pollution adds another 870,000 deaths, the study said.

In the United States, about 20,000 people a year die from lead pollution-induced hypertension, heart disease and kidney disease, mostly as occupational hazards, Landrigan said. Lead and asbestos are America’s big chemical occupational hazards, and they kill about 65,000 people a year from pollution, he said. The study said the number of air pollution deaths in the United States in 2019 was 60,229, far more than deaths on American roads, which hit a 16-year peak of nearly 43,000 last year.

Modern types of pollution are rising in most countries, especially developing ones, but fell from 2000 to 2019 in the United States, the European Union and Ethiopia. Ethiopia’s numbers can’t quite be explained and may be a reporting issue, said study co-author Richard Fuller, founder of the Global Alliance on Health and Pollution and president of Pure Earth, a non-profit that works on pollution clean-up programs in about a dozen countries.

The study authors came up with eight recommendations to reduce pollution deaths, highlighting the need for better monitoring, better reporting and stronger government systems regulating industry and cars.

“We absolutely know how to solve each one of those problems,” Fuller said. “What’s missing is political will.”

Phys Org, 18 May 2022

<https://phys.org>

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Google Reverses Ban on Ads for All Stem Cell Therapies, Will Allow FDA-Approved Ones

2022-05-09

Google announced Monday it will allow ads for stem cell treatments approved by the Food and Drug Administration to appear in search results starting in July. The tech giant previously banned any ads for stem cell therapies, FDA-approved or otherwise.

In an update to its policies page first spotted by Gizmodo, the company said that, starting July 11, it will permit search engine ads for stem cell therapies given the thumbs up from the FDA, a very small list of just 23 companies that treat some blood disorders and cancers, according to the FDA’s website.

At the same time, Google is “clarifying” its policy language on stem cell therapy ads, which would allow a global cell or gene therapy company to advertise if the ads are “exclusively educational or informational in nature, regardless of regulatory approval status.” Google did not clarify what would constitute “educational or informational,” nor did the company respond to a request for comment how it will restrict less-than-reputable products from being advertised with its technology going forward. We will update the story if we hear more.

The search engine said it banned all advertising for stem cell treatments back in 2019, proclaiming at the time it was restricting ads “that have no established biomedical or scientific basis.” In 2021, the company clarified that it was restricting ads for experimental treatments meant for so-called biohacking or other DIY genetic engineering, as well as any cell or gene therapies like stem cell therapy.

Despite the pledge to ban such ads or Monday’s announced change, a simple Google search reveals just how easily bad actors can get around the restrictions. Searching for “stem cells for neuropathy” reveals several misleading ad results for stem cell treatments that are not FDA approved, though at least one maker claims it is “FDA registered” and another says its treatment is “supported by FDA master files.”

Paul Knoepfler, a professor at the University of California Davis School of Medicine who researches stem cells and cancer, has written before about Google’s problematic search engine ad policies that allow stem cell companies to easily advertise their products in spite of the tech giant’s rules. In an email, he told Gizmodo he is concerned “How effectively the new rule for strictly educational ads would be maintained, particularly

The tech giant previously barred any ads for stem cell therapies, FDA-approved or otherwise, though companies appeared to easily skirt the restriction.

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given the context of Google Search now so often highly ranking promotional clinic websites arguably presented as educational material.”

Stem cells as an industry have grown rapidly in recent years and are expected to continue doing so, with MarketWatch reporting in February the \$2.75 billion industry is expected to more than double to \$5.72 billion by 2028.

Stem cell treatments are approved by the FDA’s Cellular, Tissue and Gene Therapies Advisory Committee. Though some companies claim in advertising they have FDA approval, being listed on clinicaltrials.gov database or being registered with the FDA isn’t full-on approval, according to the agency’s guidelines. The fact that companies regularly run around Google’s existing policies leaves even more questions on the table. Knoepfler asked whether clinical trial recruitment be allowed, when he’s often seen such trials already claiming their “treatment” already works.

“Perhaps good citizens in the regenerative medicine world want the opportunity to run such ads related to clinical trial recruitment, but even exclusively educational ads of that type with good intentions could run into ethical issues,” Knoepfler added.

Gizmodo, 9 May 2022

<https://gizmodo.com>

Making chemical separation more eco-friendly with nanotechnology

2022-05-09

Chemical separation processes are essential in the manufacturing of many products from gasoline to whiskey. Such processes are energetically costly, accounting for approximately 10–15 percent of global energy consumption. In particular, the use of so-called “thermal separation processes,” such as distillation for separating petroleum-based hydrocarbons, is deeply ingrained in the chemical industry and has a very large associated energy footprint. Membrane-based separation processes have the potential to reduce such energy consumption significantly.

Membrane filtration processes that separate contaminants from the air we breathe and the water we drink have become commonplace. However, membrane technologies for separating hydrocarbon and other organic materials are far less developed.

The use of so-called “thermal separation processes,” such as distillation for separating petroleum-based hydrocarbons, is deeply ingrained in the chemical industry and has a very large associated energy footprint.

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Penn Engineers are developing new membranes for energy-efficient organic separations by rethinking their physical structure on the nanoscale.

Nanofiltration using self-assembling membranes has been a major research area for Chinedum Osuji, Eduardo D. Glandt Presidential Professor in the Department of Chemical and Biomolecular Engineering, and his lab. The performance of these membranes was highlighted in a previous study describing how the structure of the membrane itself helped to minimize the limiting tradeoff between selectivity and permeability that is encountered in traditional nanofiltration membranes. This technology was also included in last year’s Y-Prize competition, and the winners have advanced a case for its use to produce non-alcoholic beer and wine in a startup called LiberTech.

Now, Osuji’s latest study adapts the membrane for filtration in organic solutions such as ethanol and isopropyl alcohol, and its self-assembling molecules make it more efficient than traditional organic-solvent nanofiltration (OSN).

The study, published in *Science Advances*, describes how the uniform pores of this membrane, can be fine-tuned by changing the size or concentration of the self-assembling molecules that ultimately form the material. This tunability now opens doors for the use of this membrane technology in solving more diverse real-world organic filtration problems. Researchers in the Osuji lab, including first author and former postdoctoral researcher, Yizhou Zhang, postdoctoral researcher, Dahin Kim and graduate student, Ruiqi Dong, as well as Xunda Feng of Donghua University, contributed to this work.

One challenge the team faced was the difficulty of maintaining membrane stability in organic solvents with different polarities. They selected molecular species, surfactants, that exhibited low solubility in organic fluids, and which could be effectively linked together chemically to provide the required stability. The surfactants self-assemble in water when they are above a certain concentration, and form a soft gel. Such self-assembly—the formation of an ordered state—as a function of concentration is referred to as lyotropic behavior: “lyo-” referring to solution, and “-tropic” referring to order. The gels thus formed are called lyotropic mesophases.

The membranes developed in this study were created by forming first forming lyotropic mesophases of the surfactant in water, spreading the soft gel as a thin film, and then using a chemical reaction to link the

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surfactants together to form a nanoporous polymer. The size of the pores in the polymer are set by the self-assembled structure of the lyotropic mesophase.

“At a certain concentration in an aqueous solution, the surfactant molecules aggregate and form cylindrical rods, and then those rods will self-assemble into a hexagonal structure, yielding a gel-like material,” says Osuji. “One of the ways we can manipulate the permeability, or size of the pores in our membranes, is by changing the concentration and size of the surfactant molecules used to create the membrane itself. In this study, we manipulated both of those variables to tune our pore sizes from 1.2 nanometers down to 0.6 nanometers.”

These membranes are compatible with organic solvents and can be tailored to address different separation challenges. Organic solvent nanofiltration can reduce the footprint of traditional thermal separation processes. The uniform pore size of the membranes developed here provide compelling advantages in terms of membrane selectivity, and ultimately, energy efficiency as well.

“A specific application for this technology is in biofuel production,” says Osuji. “The isolation of water-miscible alcohols from bioreactors is a key step in the manufacturing of ethanol and butanol biofuels. Membrane separations can reduce the energy used in separation of the product alcohols or fuels, from the aqueous medium in the reactor. The use of membranes is particularly advantageous in smaller scale operations such as this, where distillation is not cost effective.”

“Additionally, the manufacturing of many pharmaceutical products often involves several steps of synthesis in different solvent environments. Those steps require the transfer of a chemical intermediate from one solvent to another miscible solvent, making this new membrane a perfect solution to drug development filtration needs.”

Next steps for their research involve both theory and practice. The team plans to develop new models for membrane rejection and permeability that address the unique flow pattern of solutions through their membranes as well as identify additional future applications for their tunable technology.

Phys Org, 9 May 2022

<https://phys.org>

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Stanford coral study pinpoints cause of sunscreen's toxic effects

2022-05-10

Sunscreens are known to pose a risk to coral reefs through a common ingredient called oxybenzone, but the precise mechanisms underlying these toxic effects are not well understood. Stanford scientists have now shown how corals convert the compound into a potent toxin, creating the basis for alternative sunscreens that don't compromise the health of the reefs.

The threat oxybenzone poses to coral reefs is well-established, with a number of governments around the world actually banning sunscreens containing the compound. Hawaii become the first US state to ban these products in 2021, while the Pacific nation of Palau, the US Virgin Islands and Bonaire in the Caribbean are among the others to follow suit. Around 6,000 tons of sunscreen washes across reef areas in the US each year, according to the National Park Service.

While the dangers are clear, the toxic mechanisms tying oxybenzone to the death of corals are not. The authors of the new study have spent the last few years investigating the matter, and a set of recent experiments has provided some meaningful answers. The scientists used sea anemones and mushroom corals as models, and exposed them to oxybenzone in a tank filled with artificial seawater.

In one of the experiments, this treatment was combined with simulated sunlight, which saw all anemones die off within 17 days. Interestingly, in a parallel experiment where there was no sunlight, the creatures all remained viable. This runs counter to what the scientists expected from oxybenzone, which is designed to absorb light energy and dissipate it as heat to prevent sunburn.

“It was strange to see that oxybenzone made sunlight toxic for corals – the opposite of what it is supposed to do,” said study author William Mitch. “The compound is good at absorbing light within the waveband we tested, which is why it's so common in sunscreens.”

What the scientists found, was that under sunlight the anemones and corals were actually attaching glucose to oxybenzone and converting it through a metabolic process into a potent toxin. Interestingly, the scientists found that the symbiotic algae that live in the coral tissue were actually acting in their defense, soaking up some of the toxins the corals were producing.

In one of the experiments, this treatment was combined with simulated sunlight, which saw all anemones die off within 17 days.

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This could have ramifications for corals undergoing bleaching, a process in which abnormal sea conditions cause them to expel this symbiotic algae. This is already known to leave corals more susceptible to disease and death, and the idea that it could make them more prone to the toxic effects of oxybenzone only compounds the issue.

There are alternative sunscreens on the market that are billed as coral-safe options, which work in a different way to those with oxybenzone. But the possibility that similar metabolic pathways could create toxins in these scenarios isn't out of the question, with the scientists planning to conduct more research and ascertain their true safety for corals.

"In environmental science, as in medicine, a sound understanding of basic mechanisms should provide the best guidance for the development of practical solutions," said John Pringle, a professor of genetics at the Stanford School of Medicine.

The research was published in the journal Science.

New Atlas, 10 May 2022

<https://newatlas.com>

AI traffic light system could make traffic jams a distant memory

2022-05-11

Long queues at traffic lights could be a thing of the past, thanks to a new artificial intelligence system developed by Aston University researchers.

The system—the first of its kind—reads live camera footage and adapts the lights to compensate, keeping the traffic flowing and reducing congestion.

The system uses deep reinforcement learning, where a program understands when it is not doing well and tries a different course of action—or continues to improve when it makes progress.

In testing, the system significantly outperformed all other methods, which typically rely on manually-designed phase transitions.

In 2019, it was estimated that congestion across the UK's urban areas leads to the average UK resident wasting around 115 hours of time—and £894 in fuel waste and lost income—every year. A major cause of congestion is inadequate traffic signal timings.

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The researchers built a state of the art photo-realistic traffic simulator, Traffic 3D, to train their program, teaching it to handle different traffic and weather scenarios. When the system was tested on a real junction, it subsequently adapted to real traffic intersections despite being trained entirely on simulations. It could therefore be effective in many real-world settings.

Dr. Maria Chli, reader in Computer Science at Aston University, explained that they "have set this up as a traffic control game. The program gets a 'reward' when it gets a car through a junction. Every time a car has to wait or there's a jam, there's a negative reward. There's actually no input from us; we simply control the reward system."

At present, the main form of traffic light automation used at junctions depends on magnetic induction loops; a wire sits on the road and registers cars passing over it. The program counts that and then reacts to the data. Because the AI created by the Aston University team "sees" high traffic volume before the cars have gone through the lights and makes its decision then, it is more responsive and can react more quickly.

Dr. George Vogiatzis, senior lecturer in Computer Science at Aston University, says that "the reason we have based this program on learned behaviors is so that it can understand situations it hasn't explicitly experienced before. We've tested this with a physical obstacle that is causing congestion, rather than traffic light phasing, and the system still did well. As long as there is a causal link, the computer will ultimately figure out what that link is. It's an intensely powerful system."

The program can be set up to view any traffic junction—real or simulated—and will start learning autonomously. The reward system can be manipulated, for example to encourage the program to let emergency vehicles through quickly. But the program always teaches itself, rather than being programmed with specific instructions.

The researchers hope to begin testing their system on real roads this year.

The research paper, Fully-Autonomous, Vision-based Traffic Signal Control: from Simulation to Reality, is being presented at the Autonomous Agents and Multi-agent Systems Conference 2022 being held virtually this week.

TechXplore, 11 May 2022

<https://techxplore.com>

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A first: Scientists grow plants in soil from the Moon

2022-05-12

Scientists have grown plants in soil from the Moon, a first in human history and a milestone in lunar and space exploration.

In a new paper published in the journal *Communications Biology*, University of Florida researchers showed that plants can successfully sprout and grow in lunar soil. Their study also investigated how plants respond biologically to the Moon's soil, also known as lunar regolith, which is radically different from soil found on Earth.

This work is a first step toward one day growing plants for food and oxygen on the Moon or during space missions. More immediately, this research comes as the Artemis Program plans to return humans to the Moon.

"Artemis will require a better understanding of how to grow plants in space," said Rob Ferl, one of the study's authors and a distinguished professor of horticultural sciences in the UF Institute of Food and Agricultural Sciences (UF/IFAS).

Even in the early days of lunar exploration, plants played an important role, said Anna-Lisa Paul, also one of the study's authors and a research professor of horticultural sciences in UF/IFAS.

"Plants helped establish that the soil samples brought back from the moon did not harbor pathogens or other unknown components that would harm terrestrial life, but those plants were only dusted with the lunar regolith and were never actually grown in it," Paul said.

Paul and Ferl are internationally recognized experts in the study of plants in space. Through the UF Space Plants Lab, they have sent experiments on space shuttles, to the International Space Station and on suborbital flights.

"For future, longer space missions, we may use the Moon as a hub or launching pad. It makes sense that we would want to use the soil that's already there to grow plants," Ferl said. "So, what happens when you grow plants in lunar soil, something that is totally outside of a plant's evolutionary experience? What would plants do in a lunar greenhouse? Could we have lunar farmers?"

To begin to answer these questions, Ferl and Paul designed a deceptively simple experiment: plant seeds in lunar soil, add water, nutrients and light, and record the results.

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The complication: The scientists only had 12 grams—just a few teaspoons—of lunar soil with which to do this experiment. On loan from NASA, this soil was collected during the Apollo 11, 12 and 17 missions to the Moon. Paul and Ferl applied three times over the course of 11 years for a chance to work with the lunar regolith.

The small amount of soil, not to mention its incalculable historical and scientific significance, meant that Paul and Ferl had to design a small scale, carefully choreographed experiment. To grow their tiny lunar garden, the researchers used thimble-sized wells in plastic plates normally used to culture cells. Each well functioned as a pot. Once they filled each "pot" with approximately a gram of lunar soil, the scientists moistened the soil with a nutrient solution and added a few seeds from the *Arabidopsis* plant.

Arabidopsis is widely used in the plant sciences because its genetic code has been fully mapped. Growing *Arabidopsis* in the lunar soil allowed the researchers more insight into how the soil affected the plants, down to the level of gene expression.

As points of comparison, the researchers also planted *Arabidopsis* in JSC-1A, a terrestrial substance that mimics real lunar soil, as well as simulated Martian soils and terrestrial soils from extreme environments. The plants grown in these non-lunar soils were the experiment's control group.

Before the experiment, the researchers weren't sure if the seeds planted in the lunar soils would sprout. But nearly all of them did.

"We were amazed. We did not predict that," Paul said. "That told us that the lunar soils didn't interrupt the hormones and signals involved in plant germination."

However, as time went on, the researchers observed differences between the plants grown in lunar soil and the control group. For example, some of the plants grown in the lunar soils were smaller, grew more slowly or were more varied in size than their counterparts.

These were all physical signs that the plants were working to cope with the chemical and structural make-up of the Moon's soil, Paul explained. This was further confirmed when the researchers analyzed the plants' gene expression patterns.

"At the genetic level, the plants were pulling out the tools typically used to cope with stressors, such as salt and metals or oxidative stress, so we can infer that the plants perceive the lunar soil environment as stressful," Paul said. "Ultimately, we would like to use the gene expression data to help

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address how we can ameliorate the stress responses to the level where plants—particularly crops—are able to grow in lunar soil with very little impact to their health.”

How plants respond to lunar soil may be linked to where the soil was collected, said Ferl and Paul, who collaborated on the study with Stephen Elardo, an assistant professor of geology at UF.

For instance, the researchers found that the plants with the most signs of stress were those grown in what lunar geologists call mature lunar soil. These mature soils are those exposed to more cosmic wind, which alters their makeup. On the other hand, plants grown in comparatively less mature soils fared better.

Growing plants in lunar soils may also change the soils themselves, Elardo said.

“The Moon is a very, very dry place. How will minerals in the lunar soil respond to having a plant grown in them, with the added water and nutrients? Will adding water make the mineralogy more hospitable to plants?” Elardo said.

Follow up studies will build on these questions and more. For now, the scientists are celebrating having taken the first steps toward growing plants on the Moon.

“We wanted to do this experiment because, for years, we were asking this question: Would plants grow in lunar soil,” Ferl said. “The answer, it turns out, is yes.”

Phys Org, 12 May 2022

<https://phys.org>

This Anti-Aging Technique Makes Human Skin Cells Act 30 Years Younger, Scientists Claim

2022-05-06

Fifteen years ago, scientists made a stirring discovery when they demonstrated that they could reverse the process of aging in cells. By activating a set of four factors in the DNA, they reset the cell’s clock to zero, reverting adult cells to their embryonic state. The factors were named Yamanaka factors after their discoverer, Shinya Yamanaka, and a few years later, they earned him a Nobel Prize. For the first time, scientists saw a glimmer of hope that aging could be reversed.

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“It’s quite amazing if you think about it,” Wolf Reik, a molecular biologist at the Babraham Institute in the United Kingdom, tells Popular Mechanics. “You can potentially reset the age of human cells back to zero.”

Scientists hoped that these cells, stripped of the tell-tale signs of aging, could be used to repair and rejuvenate damaged organs. Younger, healthier nerve cells, for example, could take over for brain cells killed by a stroke, or collagen-boosting skin cells could be injected directly into stubborn wounds. The only problem is that the Yamanaka factors reset the cells too far. A cell that is zero days old can’t send an electrical nervous signal or produce collagen, nor carry on any other function. Like a stem cell, it is nothing more than a blob of potential.

To overcome this, scientists have been tinkering with the timing and looking for ways to halt the reverse-aging process at the precise moment before the cell reverts to its embryonic form. Previous efforts in mice have shown some promise, but the gains have been modest, reversing the clock only three years or so.

But now, a group of scientists led by Reik showed that they could turn back the clock by up to 30 years. It is the farthest back anyone has gone without going too far. In April, they published the results in eLife.

“What’s new and interesting in this study is that they push the cells into reprogramming in a time-controlled way,” Manuel Serrano—a molecular biologist at Barcelona, Italy’s Institute for Research in Biomedicine, who was not involved in the study—tells Popular Mechanics. Serrano says that up until now, scientists were not really able to control the Yamanaka factors with much certainty.

To start, researchers collected skin cells from middle-aged adults between 38 and 53 years old. They specifically collected skin fibroblast cells, which are essential for wound healing and whose effectiveness declines with age. Using viral vectors, they injected the Yamanaka factors (a set of four genes) into the cells and turned them on. Previous research showed that it takes a total of 50 days for the Yamanaka factors to reset the clock to zero, and that between Day 10 and Day 17, the cells were roughly 20 to 40 years old, respectively. The researchers decided to halt the action of the Yamanaka factors during this period, looking at the effects on the cells between Day 10 and Day 17.

At each pause, researchers evaluated the biological age of the cells using molecular “aging clocks.” Changes to the DNA that cause cancer, called epigenetic changes, were measured. They also measured collagen

“What’s new and interesting in this study is that they push the cells into reprogramming in a time-controlled way”

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production because this protein imbues young skin with its characteristic firm and plump texture, but it declines with age. They even measured the cell's mobility. When the skin is damaged, fibroblasts physically migrate into the wound to kick-start collagen production and initiate the repair process. As they age, fibroblasts become noticeably slower, which explains why older skin takes longer to heal.

The scientists found the sweet spot after just 13 days. The cells were youthful, but still retained their ability to produce collagen and move quickly into damaged areas. "Understanding that we could rejuvenate cells was amazing," Inês Milagre—a researcher at the Gulbenkian Institute of Science in Portugal, and an author on the new study—tells Popular Mechanics. "But the most exciting thing was to see that the cells were functionally younger," she says.

According to Milagre, the work is an important milestone and proof that the Yamanaka factors can be fine-tuned. However, she says that we should not expect the technique to be available in the clinic anytime soon. The activation of the Yamanaka factors can cause cancer, and it is still unclear whether this process will work in other cell types. "There are still so many unknowns," she says.

Reik echoes these concerns and has plans to develop safer strategies. He thinks by better pinpointing how Yamanaka factors work, he will be able to find downstream molecules that are turned on by the genetic factors. By identifying those factors, which may be RNA or protein, he could develop therapeutics that don't require messing with the genes in the cell, therefore lowering the risk of cancer and other side effects.

"We could call them 'rejuvenation factors,' and they would provide a safer way of rejuvenating cells," Reik says.

Popular Mechanics, 6 May 2022

<https://popularmechanics.com>

University of Cambridge researchers use algae to power computer

2022-05-15

Researchers have used algae to power a computer continuously for a year.

The University of Cambridge said the system was a similar size to an AA battery and contained a non-toxic species of blue-green algae called *synechocystis*.

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The algae "naturally harvests energy from the sun through photosynthesis", the university said.

Researchers believe the system "has potential as a reliable and renewable way to power small devices".

They said the system was made of "common, inexpensive and largely recyclable materials".

"This means it could easily be replicated hundreds of thousands of times to power large numbers of small devices as part of the Internet of Things," the team said.

'Consistently worked'

The Internet of Things is a vast and growing network of electronic devices that each use a small amount of power that collect and share real-time data via the internet, like smartwatches.

The electrical current generated through photosynthesis interacts with an aluminium electrode which is used to power the microprocessor.

Prof Christopher Howe, of the University of Cambridge's department of biochemistry, said: "Our photosynthetic device doesn't run down the way a battery does because it's continually using light as the energy source."

In the experiment, the device was used to power an Arm Cortex M0+, which is a microprocessor used widely in Internet of Things devices.

Cambridge-based microprocessor design company Arm collaborated with the Cambridge researchers on the project.

Dr Paolo Bombelli, of the University of Cambridge's Department of Biochemistry, said: "We were impressed by how consistently the system worked over a long period of time - we thought it might stop after a few weeks but it just kept going,"

BBC News, 15 May 2022

<https://bbc.com>

The algae harvests energy from the sun through photosynthesis which generates an electrical current

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The world's most boring person discovered by researchers

2022-05-08

The most boring person in the world has been discovered by University of Essex research - and it is a religious data entry worker, who likes watching TV, and lives in a town.

The peer-reviewed study into the science of boredom has uncovered the jobs, characteristics, and hobbies that are considered a stereotypical snooze.

After examining more than 500 people across five experiments researchers found the blandest jobs are seen as data analysis, accounting, cleaning and banking.

The paper – published in the Personality and Social Psychology Bulletin – also discovered that religion, watching TV, bird watching, and smoking were amongst the duller hobbies.

Boring people were also perceived to shun large settlements to live in small cities and towns.

Led by the Department of Psychology's Dr Wijnand Van Tilburg the research revealed that stereotypically boring people are generally disliked and avoided due to preconceptions.

And people may expect to be paid a minimum of £35-a-day to spend time with them as recompense.

He launched the study to explore the stigma of perceived boredom and how it can impact perceptions.

He said: "The irony is studying boredom is actually very interesting and has many real-life impacts.

"These paper shows how persuasive perceptions of boredom are and what an impact this can have on people.

"Perceptions can change but people may not take time to speak to those with 'boring' jobs and hobbies, instead choosing to avoid them.

"They don't get a chance to prove people wrong and break these negative stereotypes.

The peer-reviewed study into the science of boredom has uncovered the jobs, characteristics, and hobbies that are considered a stereotypical snooze.

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"The very fact that people choose to avoid them can lead to social ostracization and increase loneliness leading to a really negative impact on their lives."

The study also showed that being perceived as boring likely conveys low competence and low interpersonal warmth.

Those perceived as boring may thus be at greater risk of harm, addiction and mental health issues.

And despite the negative perception society needs people to perform roles such as accounting and banking.

"It was interesting to me to see the study showed that boring people were not seen as competent," said Dr Van Tilburg.

"I would have thought that accountants would be seen as boring, but effective and the perfect person to do a good job on your tax return.

"The truth of the matter is people like bankers and accountants are highly capable and have power in society - perhaps we should try not to upset them and stereotype them as boring!"

Lists:

The top five most boring jobs:

1. Data Analysis
2. Accounting
3. Tax/insurance
4. Cleaning
5. Banking

The top five most exciting jobs

6. Performing arts
7. Science
8. Journalism
9. Health professional
10. Teaching

The top five most boring hobbies

11. Sleeping
12. Religion
13. Watching TV

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- 14. Observing animals
- 15. Mathematics

The Brighter Side of News, 8 May 2022

<https://thebrighterside.news>

Your clothes can have an afterlife: Strategies for greater reuse and recycling of textiles

2022-05-09

Only about 15% of used clothes and other textiles in the United States get reused or recycled. The other 85% head straight to the landfill or incinerator. This wastes scarce resources, contributes to climate change and pollutes waterways.

In a new report from the National Institute of Standards and Technology (NIST), *Facilitating a Circular Economy for Textiles*, scientists recommend strategies to address this problem. The circular economy referenced in the title is one in which materials remain in the economy longer through repeated reuse, repair and recycling, and are finally discarded only as a last resort.

The report is based on a three-day workshop held at NIST in September 2021 that brought together manufacturers, industry associations, recyclers, waste managers, researchers, policymakers and several major fashion brands that share the goal of increasing circularity in the textiles industry.

"Textiles are one of the fastest growing categories in the waste stream," said Kelsea Schumacher, an environmental engineer working with NIST who co-authored the report. "But there are a lot of opportunities to reduce waste in this sector that would bring big economic and environmental benefits."

The report defines textiles to include clothing, shoes, bedding, towels, upholstery fabrics and carpeting. However, the main type of textile in the municipal waste stream, according to the Environmental Protection Agency (EPA), is discarded clothing. On average, each person in the United States discarded roughly 47 kilograms (103 pounds) of textiles in 2018, the most recent year for which data is available.

Many people donate used clothing. But clothes and other textiles that are too old or worn can still have an afterlife in other products. For example, they can be cut and resold by industrial rag manufacturers. The fibers can

Many people donate used clothing. But clothes and other textiles that are too old or worn can still have an afterlife in other products.

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also be separated and recycled back into new textiles or used as stuffing for upholstered furniture and car seats or home insulation material.

The authors of the report compiled data from multiple sources to create a flow diagram that shows what happens to textiles in the United States after they are donated or discarded.

One obstacle to greater reuse and recycling cited in the report is that consumers lack information about how to dispose of their used textiles. For instance, many people don't realize that they can recycle them. Cities and towns often have textile recycling drop-off centers that can be found with a quick internet search.

But consumer knowledge can only go so far. The report recommends other improvements that businesses and governments can undertake to increase reuse and recycling of textiles. These include better sorting and grading technologies, advanced labeling and digital product identification, advanced recycling processes for certain synthetics that are not currently recyclable, standardized terminology and classifications, and better data collection.

NIST undertook this effort as part of its larger circular economy initiative, which until now has focused mainly on ways to keep plastics circulating within the economy, rather than ending up in landfills or polluting the environment.

"Circular economy is about more than just recycling," said NIST materials scientist and report co-author Amanda Forster. "It's about keeping products in their useful form for as long as possible, then when you can't use them anymore, finding a way to recycle them that preserves as much of their value as possible, and only sending them to the landfill as a last resort."

Phys Org, 9 May 2022

<https://phys.org>

How microplastics in the air are polluting the most remote places on Earth

2022-05-10

Microplastics are being transported to some of the most remote places on Earth by the wind, according to new research involving the University of East Anglia. A new study published today in *Nature Reviews Earth &*

"We know that these tiny plastic particles have even reached the Arctic, the Antarctic and the ocean depths, via ocean currents and rivers."

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Environment shows how wind transports these particles great distances, and much faster than water can.

In the atmosphere, these microscopic pieces of plastic can travel from their point of origin to the most remote corners of the planet in a matter of days.

Back in 2018, Dr. Andrew Mayes, from UEA's School of Chemistry, developed a new way of detecting microplastics in water and went on to find microplastics in bottled water around the world.

He said: "Microplastics are small plastic particles, which come from a variety of sources including cosmetics, clothing, industrial processes, packaging materials and degradation of larger plastic items.

"It is known that microplastics are found in the environment at high levels, particularly in aquatic and marine ecosystems, but also in the soil and in the air we breathe.

"We know that these tiny plastic particles have even reached the Arctic, the Antarctic and the ocean depths, via ocean currents and rivers.

"We wanted to better understand how microplastics find their way into the atmosphere, and how they are subsequently transported into our planet's waters."

The research, led by Dr. Deonie Allen and Dr. Steve Allen from the University of Strathclyde, involved collecting samples of microplastic in the air, seawater and ice during a Polarstern expedition to the Arctic last year.

Dr. Mayes said: "Microplastics get into the atmosphere through human activities. Particles produced by tires and brakes in road traffic, or by the exhaust gases from industrial processes, rise into the atmosphere, where they are transported by winds.

"We found that the atmosphere predominantly transports small microplastic particles, which makes it a much faster transport route that can lead to substantial deposits in a broad range of ecosystems."

The team discovered that up to 25 million metric tons of micro and nanoplastics are being transported thousands of kilometers a year by ocean air, snow, sea spray and fog—crossing countries, continents and oceans in the process.

And according to their estimates, this could reach 80 million metric tons per year by 2040.

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Prof Peter Liss, from UEA's School of Environmental Sciences, said: "In contrast to the usual assumption that microscopic pieces of plastic enter the ocean down rivers, our work makes the case for the significance of the atmosphere as an alternative route of entry.

"It also sets out a way for this idea to be tested in future research. The potential implications of the atmospheric route for policy to decrease plastic pollution of the oceans are serious since rivers and atmosphere need to be tackled in very different regulatory ways."

Collaborator Dr. Melanie Bergmann from the Alfred Wegener Institute in Germany, said: "Air is a much more dynamic medium than water. As a result, micro and nanoplastic can much more quickly penetrate those regions of our planet that are most remote and still largely untouched."

Once there, the particles could affect the surface climate and the health of local ecosystems. For example, when these darker particles are deposited on snow and ice, they affect the ice-albedo feedback, reducing their ability to reflect sunlight and promoting melting.

Similarly, darker patches of seawater absorb more solar energy, further warming the ocean. And in the atmosphere, microplastic particles can serve as condensation nuclei for water vapor, producing effects on cloud formation and, in the long term, the climate.

The team also found that a substantial number of these particles are transported by the marine environment. Initial analyses show that microplastic from the coastal zone finds its way into the ocean through eroded beach sand.

The combination of sea spray, wind and waves forms air bubbles in the water containing microplastic. When the bubbles burst, the particles find their way into the atmosphere. As such, transport to remote and even polar regions could be due to the combination of atmospheric and marine transport.

Consequently, it is important to understand interactions between the atmosphere and ocean, to determine which particle sizes are transported, and in which quantities.

Understanding and characterizing the microplastic cycles between the ocean and atmosphere will require joint efforts. The study outlines a global strategy for creating a seamless, intercomparable database on the flow of micro and nanoplastic between the ocean and atmosphere.

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“There are so many aspects of the emissions, transport and effects of microplastic in the atmosphere that we still don’t fully understand,” says co-author Prof Tim Butler from the Institute for Advanced Sustainability Studies (IASS). “This publication reveals the gaps in our knowledge—and presents a roadmap for the future.”

“Microplastics and nanoplastics in the marine-atmosphere environment” was published in the journal Nature Reviews Earth and Environment on May 10, 2022.

Phys Org, 10 May 2022

<https://phys.org>

The future of nuclear waste: What’s the plan and can it be safe?

2022-05-10

The U.K. is planning to significantly expand its nuclear capability, in an effort to decrease its reliance on carbon-based fossil fuels. The government is aiming to construct up to eight new reactors over the next couple of decades, with a view to increasing power capacity from approximately 8 gigawatts (GW) today to 24GW by 2050. This would meet around 25% of the forecast U.K. energy demand, compared to around 16% in 2020.

As part of this plan to triple nuclear capacity, also in the works is a £210 million investment for Rolls-Royce to develop and produce a fleet of small modular reactors (SMRs). SMRs are cheaper and can be used in locations which can’t host traditional, larger reactors, so this will give more options for future nuclear sites.

New reactors will inevitably mean more radioactive waste. Nuclear waste decommissioning, as of 2019, was already estimated to cost U.K. taxpayers £3 billion per year. The vast majority of our waste is held in storage facilities at or near ground level, mostly at Sellafield nuclear waste site in Cumbria, which is so large it has the infrastructure of a small town.

But above-ground nuclear storage isn’t a feasible long term plan—governments, academics and scientists are in agreement that permanent disposal below ground is the only long-term strategy that satisfies security and environmental concerns. So what plans are underway, and can they be delivered safely?

The way forward

Previous ideas have included disposing of the extra waste in space, in the sea and below the ocean floor where tectonic plates converge, but each has been shelved as too risky.

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It has taken many decades of international collaboration between academic and scientific institutions and government regulators to identify a feasible route towards the ultimate disposal of nuclear waste. Previous ideas have included disposing of the extra waste in space, in the sea and below the ocean floor where tectonic plates converge, but each has been shelved as too risky.

Now, almost every nation plans to isolate radioactive waste from the environment in an underground, highly engineered structure called a geological disposal facility (GDF). Some models see GDFs constructed at 1,000 meters underground but 700 meters is more realistic. These facilities will receive low, intermediate or high level nuclear wastes (classified as such according to radioactivity and half-life) and store them safely for up to hundreds of thousands of years.

The process for creating such a facility is not simple. The organization responsible for delivering the GDF, which in the U.K. is Nuclear Waste Services (NWS), must not only overcome huge environmental and technical issues but also earn the public’s support.

Will all GDFs look the same?

Although generic design concepts do exist, each GDF will have unique aspects based on the size and constitution of the waste inventory and the geology of where it is installed. Every nation will tailor its GDF to its individual needs, under the scrutiny of regulators and the public.

Underpinning all GDFs, however, will be what is known as the multi-barrier concept. This combines man-made and natural barriers to isolate nuclear waste from the environment, and allow it to steadily decay.

The system for preparing high-level waste for storage in such a system will start with spent nuclear fuel rods from reactors. First, any uranium and plutonium that is still usable for future reactions will be recovered. The residual waste will then be dried and dispersed into a host glass, which is used because glass is tough, durable in groundwater and resistant to radiation. The molten glass will then be poured into a metal container and solidified, so that there are two layers of protection.

This packaged waste will then be surrounded by a backfill of clay or cement, which seals the excavated rock cavities and underground tunnel structures. Hundreds of meters of rock itself will act as the final layer of containment.

How is the UK program going?

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The U.K. GDF program is in its early stages. The siting process operates on a so-called volunteerism approach, in which communities can put themselves forward as potential sites to host the facility. At present, a working group (Theddlethorpe, Lincolnshire) and three community partnerships (Allerdale, Mid Copeland and South Copeland in Cumbria) have formed. Whilst working groups are at earlier stages of the siting process, the next steps for community partnerships are to begin more extensive geological surveys, followed by drilling boreholes to assess the underlying rock.

Public support is the basis of the entire GDF program. While some nations may take a more heavy-handed approach and choose a site regardless of public support, the U.K. GDF mission has community and stakeholder engagement at its core.

Why would residents volunteer? This is a 100+ year project that will require a lot of people working very close by. At the community partnership stage, an investment of up to £2.5million per year, per community, is expected.

The U.K. program is some way behind certain other nations. The world leader is Finland, which has almost finished the world's first GDF at Onkalo, several hundred kilometers west of Helsinki. Preferred sites for GDFs have also been selected in the U.S., Sweden and France.

The U.K. government aims to identify a suitable site within the next 15–20 years, after which construction can start. The timescale from siting to closing and sealing the first U.K. GDF is 100 years, making this the largest U.K. infrastructure project ever. The technology to deliver the GDF is ready; all that remains is to find a willing community with a suitable geology.

Is there another way?

It is the scientific consensus, internationally, that the GDF approach is the most technically feasible way to permanently dispose of nuclear waste. Onkalo is an example to the world that scientific collaboration and open engagement with the public can make safe disposal of nuclear waste possible.

The only other approach that has received any traction is the deep borehole disposal (DBD) concept. At face value, this is not too dissimilar from a GDF approach; drilling boreholes much deeper than a GDF would

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be (up to several kilometers) and putting waste packages at the bottom. Countries such as Norway are considering this approach.

Tech Xplore, 10 May 2022

<https://techxplore.com>

Gravity signals could detect earthquakes at the speed of light

2022-05-11

Two minutes after the world's biggest tectonic plate shuddered off the coast of Japan, the country's meteorological agency issued its final warning to about 50 million residents: A magnitude 8.1 earthquake had generated a tsunami that was headed for shore. But it wasn't until hours after the waves arrived that experts gauged the true size of the 11 March 2011 Tohoku quake. Ultimately, it rang in at a magnitude 9—releasing more than 22 times the energy experts predicted and leaving at least 18,000 dead, some in areas that never received the alert. Now, scientists have found a way to get more accurate size estimates faster, by using computer algorithms to identify the wake from gravitational waves that shoot from the fault at the speed of light.

"This is a completely new [way to recognize] large-magnitude earthquakes," says Richard Allen, a seismologist at the University of California, Berkeley, who was not involved in the study. "If we were to implement this algorithm, we'd have that much more confidence that this is a really big earthquake, and we could push that alert out over a much larger area sooner."

Scientists typically detect earthquakes by monitoring ground vibrations, or seismic waves, with devices called seismometers. The amount of advance warning they can provide depends on distance between the earthquake and the seismometers, and the speed of the seismic waves, which travel less than 6 kilometers per second. Networks in Japan, Mexico, and California provide seconds or even minutes of advance warning, and the approach works well for relatively small temblors. But beyond magnitude 7, the earthquake waves can saturate seismometers. This makes the most destructive earthquakes, like Japan's Tohoku quake, the most challenging to identify, Allen says.

Recently, researchers involved in the hunt for gravitational waves—ripples in space-time created by the movement of massive objects—realized that those gravity signals, traveling at the speed of light, might also be used to

Algorithm set for deployment in Japan could identify giant temblors faster and more reliably

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monitor earthquakes. “The idea is that as soon as mass moves anywhere, the gravitational field changes, and ... everything feels it,” says Bernard Whiting, a physicist at the University of Florida who worked on the Laser Interferometer Gravitational-Wave Observatory. “What was amazing was that the signal would be present even in seismometers.”

Sure enough, in 2016, Whiting and his colleagues reported that regular seismometers could detect these gravity signals. Earthquakes result in large shifts in mass; those shifts give off gravitational effects that deform both existing gravitational fields and the ground beneath seismometers. By measuring the difference between these two, the scientists concluded they could create a new kind of earthquake early warning system. Gravitational signals show up on seismometers before the arrival of the first seismic waves, in a portion of the seismogram that’s traditionally ignored. By combining signals from dozens of seismometers on top of one another, scientists can identify patterns to interpret the size and location of large events, Whiting says.

Now, Andrea Licciardi, a postdoc at Côte d’Azur University, and his colleagues have built a machine-learning algorithm to do that pattern recognition. They trained the model on hundreds of thousands of simulated earthquakes before testing it on the real data set from Tohoku. The model accurately predicted the earthquake’s magnitude in about 50 seconds—faster than other state-of-the-art early warning systems, researchers report today in *Nature*.

“It’s more than the seed of an idea—they’ve shown that it can be done,” Whiting says. “What we showed was a proof of principle. What they’re showing is a proof of implementation.”

The gravity signals are too weak to be used for detecting earthquakes smaller than magnitude 8.3 with current technology, and the system is unlikely to provide much extra advance warning in earthquake zones that are already blanketed in seismometers. But it could deliver more reliable size estimates of large-magnitude earthquakes, which is crucial, particularly for predicting tsunamis, which often take an extra 10 or 15 minutes to arrive, Allen says. With this technique, seismologists in Japan could have accurately determined Tohoku’s magnitude and issued proper alerts “1 or 2 minutes after the beginning of the earthquake,” says Jean-Paul Ampuero, a seismologist also at Côte d’Azur University and co-author on the paper. “In 2011, it took hours. It would have been fantastic.”

But the technology isn’t operational yet: It hasn’t processed data in real time. The model is set to be deployed in Japan—but only for earthquakes

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generated by a specific fault zone likely to generate “big ones.” The algorithm needs to be trained separately for use in different regions, and the researchers are currently doing so for seismic networks in Peru and Chile, Licciardi says. Still, “We have a first-generation algorithm ... that’s a huge step forward,” Allen says. “Now let’s go and figure out if it actually works.”

Science, 11 May 2022

<https://science.org>

Candy-coated pills could prevent pharmaceutical fraud

2022-05-09

While most of us were baking sourdough bread and watching “Tiger King” to stay sane during the pandemic shutdown, UC Riverside bioengineering professor William Grover kept busy counting the colorful candy sprinkles perched on top of chocolate drops. In the process, he discovered a simple way to prevent pharmaceutical fraud.

The technique, which he calls CandyCode and uses tiny multicolored candy nonpareils or “hundreds and thousands” as a uniquely identifiable coating for pharmaceutical capsules and pills, is published in *Scientific Reports*.

Counterfeit or substandard medicines harm millions of people and cost an estimated \$200 billion annually. In the developing world, the World Health Organization estimates that one in 10 medical products is fake.

Grover’s lab has previously worked on simple, low-cost ways to ensure the authenticity of pharmaceuticals. Other researchers have been interested in putting unique codes on pills that can be used to verify their authenticity, but all of those schemes have practical limitations.

“The inspiration for this came from the little colorful chocolate candies. Each candy has an average of 92 nonpareils attached randomly, and the nonpareils have eight different colors. I started wondering how many different patterns of colored nonpareils were possible on these candies,” said Grover. “It turns out that the odds of a randomly generated candy pattern ever repeating itself are basically zero, so each of these candies is unique and will never be duplicated by chance.”

This gave Grover the idea that the nonpareils could be applied as a coating to each pill, giving it a unique pattern that could be stored by the manufacturer in a database. Consumers could upload a smartphone

The technique [...] uses tiny multicolored candy nonpareils or “hundreds and thousands” as a uniquely identifiable coating for pharmaceutical capsules and pills.

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photograph of a pill and if its CandyCode matches one in the database, the consumer could be confident that the pill is genuine. If not, it is potentially fraudulent.

To test this idea, Grover used edible cake decorating glue to coat Tylenol capsules with nonpareils and developed an algorithm that converts a photo of a CandyCoded pill into a set of text strings suitable for storing in a computer database and querying by consumers. He used this algorithm to analyze a set of CandyCode photos and found they function as universally unique identifiers, even after subjecting the CandyCoded pills to physical abuse that simulates the wear-and-tear of shipping.

“Using a computer simulation of even larger CandyCode libraries, I found that a company could produce 10^{17} CandyCoded pills—enough for 41 million pills for each person on earth—and still be able to uniquely identify each CandyCoded pill,” Grover said.

Even more unique CandyCodes could be created with the introduction of more colors or combining different sizes or shapes of candy nonpareils. CandyCodes could also be used to ensure the authenticity of other products that are often counterfeited. Bottle caps, for example, could be coated with adhesive and dipped in nonpareils to ensure the integrity of perfume or wine and garment or handbag hang tags could be coated with glitter.

CandyCoded capsules or tablets have an unexpected benefit for the consumer as well.

“Anecdotally, I found that CandyCoded caplets were more pleasant to swallow than plain caplets, confirming Mary Poppins’ classic observation about the relationship between sugar and medicine,” said Grover.

The open access paper, “CandyCodes: simple universally unique edible identifiers for confirming the authenticity of pharmaceuticals,” is available here.

The Brighter Side of News, 9 May 2022

<https://thebrighterside.news>

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Blocking Inflammation May Lead to Chronic Pain

2022-05-11

Acute pain is commonly treated with anti-inflammatory drugs. However, this practice may be short-sighted. According to a new study, inflammation may prevent acute pain from turning into chronic pain.

A transcriptome-wide analysis of peripheral immune cells from subjects with low back pain showed that neutrophil activation-dependent inflammatory genes were upregulated in subjects with resolved pain, whereas no changes were observed in patients with persistent pain. This finding—which suggests that anti-inflammatory drugs might be analgesic in the short term but prolong pain in the long term—was replicated in an independent cohort of patients with another musculoskeletal pain condition, temporomandibular disorder (TMD).

This work, which was carried out by McGill University researchers and their colleagues in Italy, was detailed in a paper (“Acute inflammatory response via neutrophil activation protects against the development of chronic pain”) that appeared in *Science Translational Medicine*. Besides presenting the transcriptomic findings, the paper described how rodent pain models were used to elucidate the mechanism mediating the transition from acute to chronic pain. Finally, the paper indicated that data from a large human cohort (UK Biobank) was used to clarify the relationship between back pain and the use of anti-inflammatory drugs.

“[We] investigated the pathophysiological mechanisms underlying the transition from acute to chronic low back pain (LBP) and performed transcriptome-wide analysis in peripheral immune cells of 98 participants with acute LBP, followed for 3 months,” the article’s authors wrote. “We found thousands of dynamic transcriptional changes over 3 months in LBP participants with resolved pain but none in those with persistent pain. Transient neutrophil-driven upregulation of inflammatory responses was protective against the transition to chronic pain.

“In rodents, anti-inflammatory treatments prolonged pain duration, and the effect was abolished by neutrophil administration,” the authors added. “Last, clinical data showed that the use of anti-inflammatory drugs was associated with increased risk of persistent pain, suggesting that anti-inflammatory treatments might have negative effects on pain duration.”

The senior authors of the article were McGill University’s Luda Diatchenko, MD, PhD, and Jeffrey S. Mogil, PhD, and Policlinico Monza’s Massimo Allegri, MD.

This finding [...] suggests that anti-inflammatory drugs might be analgesic in the short term but prolong pain in the long term.

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"In analyzing the genes of people suffering from lower back pain, we observed active changes in genes over time in people whose pain went away," said Diatchenko. "Changes in the blood cells and their activity seemed to be the most important factor, especially in cells called neutrophils." Mogil added that neutrophils dominate the early stages of inflammation and set the stage for repair of tissue damage. "Inflammation occurs for a reason," he remarked, "and it looks like it's dangerous to interfere with it."

Experimentally blocking neutrophils in mice prolonged the pain up to 10 times the normal duration. Treating the pain with anti-inflammatory drugs and steroids like dexamethasone and diclofenac also produced the same result, although they were effective against pain early on.

These findings are also supported by a separate analysis of 500,000 people in the United Kingdom that showed that those taking anti-inflammatory drugs to treat their pain were more likely to have pain two to ten years later, an effect not seen in people taking acetaminophen or anti-depressants.

"Our findings suggest it may be time to reconsider the way we treat acute pain," Allegri noted. "Luckily, pain can be killed in other ways that don't involve interfering with inflammation."

"We discovered that pain resolution is actually an active biological process," Diatchenko declared. "These findings should be followed up by clinical trials directly comparing anti-inflammatory drugs to other pain killers that relieve aches and pains but don't disrupt inflammation."

GenEng News, 11 May 2022

<https://genengnews.com>

Why Is Gallium Nitride the Next Hot Thing for Batteries?

2022-05-11

Rumors about Tesla entering the lithium-mining business started buzzing around in April after the company hired an exploration geologist from Rio Tinto, the world's second-largest metals and mining corporation. CEO Elon Musk pretty much confirmed as much in an April 8 tweet:

"Price of lithium has gone to insane levels! Tesla might actually have to get into the mining & refining directly at scale, unless costs improve. There is no shortage of the element itself, as lithium is almost everywhere on Earth, but pace of extraction/refinement is slow," Musk says.

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He has a point: lithium metal costs are soaring. According to a December 2021 S&P Global Commodities Insight report, seaborne lithium carbonate prices climbed 413 percent between January and December 2021; lithium hydroxide prices rose 254 percent over the same period. S&P Global says those costs are expected to continue soaring through 2022, leaving open questions about how to create EV batteries with renewable materials in a cost-effective manner.

The secret, it turns out, may lie in a totally different material, allowing us to use less lithium. Let us introduce you to gallium nitride (GaN), a chemical compound that has been commonly used as a semiconductor in light-emitting diodes since the 1990s.

First Off, How Do Lithium-Ion Batteries Work?

In general, batteries have an anode, a cathode, and an electrolyte. Current flows out through the anode, circulates, and then devices connected to the battery use that current before it flows back in through the cathode. From there, charged ions are pulled through the electrolyte material in order to circulate again.

In a lithium-ion battery of the almost ubiquitous design we see today, the anode material is graphite, the most plentiful naturally occurring form of carbon and a lightweight, highly conductive substance. The electrolyte is a lithium-salt liquid that is highly combustible (a discussion for another day). The cathode is one of various compounds that are made of lithium with select other elements.

Many different parts contribute to the bulk and burden of lithium-ion batteries—which means there are a lot of opportunities to improve performance in a way that reduces our dependence on dwindling lithium. Imagine you had a jar of beautiful saffron threads, and you realized just three were left. What would you do? You'd slow down and think about how to most efficiently use them in your recipes. Our jar of lithium is almost empty.

Why Is Gallium Nitride the Next Hot Thing for Batteries?

There's a ton of debate within the EV battery industry about what the next great thing will be. It could be solid lithium, which comes with challenges of its own, but offers more stability compared to volatile liquid electrolytes. It could be one of the industry's dozens of blends of lithium, or something new altogether. But it could also be something as simple as the semiconductors.

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Navitas Semiconductor is one of many companies in the space looking to make an impact on the field of EV batteries. It says that by making a simple swap—gallium nitride (GaN) for silicon—EV batteries could shed critical weight and also charge faster. It's all because of the chemical and physical makeup of GaN compared with silicon, giving GaN larger capacity with less materials.

Gallium is a soft metal in the same family as aluminum. It's solid at room temperature, but just barely, with a melting point of about 85 degrees Fahrenheit. But when combined with plentiful nitrogen, it becomes GaN, a rock-hard semiconductor material. GaN is no shrinking violet; a 2017 study from Shandong University in China, looking at GaN as an anode material, called it the "most studied III-nitride," compared with similar conductors AlN (aluminum) and InN (indium), for example.

GaN is already used in light-emitting diode (LED) light bulbs. Where traditional tungsten filament incandescent lightbulbs have an efficiency of just 5 percent, GaN LED bulbs can reach 60 percent efficiency. And it could have a similar, if not quite so dramatic, improvement over commonly used silicon as a semiconductor. That's because of something called bandgap.

In chemistry, bandgap is the distance between the conduction band and the valence band of the material's atoms. This refers to the two places where electrons are able to be passed in and out, and it helps scientists calculate how conductive different materials are. The bandgap, as the distance between these two bands, is important to other aspects of semiconductors.

Silicon has a narrow band (1.1 electron volts) and GaN has a much wider one (3.4 electron volts). This ends up meaning that the material can hold more electron-passing particles, which translates to more dense materials that can carry the same amount of current. We're saving materials by shrinking the semiconductors themselves, saving on weight, and increasing the passthrough of electrons during charging.

Navitas says in its materials that GaN is also, surprisingly, a way that we could improve the traction systems in EVs that literally translate energy into the vehicle's adhesion to the road. That means more movement with less energy, because less is wasted "spinning the wheels." Indeed,

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it seems that GaN could do a lot more with less when it comes to EV semiconductors.

Popular Mechanics, 11 May 2022

<https://popularmechanics.com>

We Could Hack Our Brains to Become Better, More Moral People

2022-05-12

Would you ever consider implanting a "virtues control panel" inside your brain, one that could turn you into a fairer and more compassionate person? Granted, you'd have to let scientists send electrical currents down your brain's neurons for about ten minutes each day, or consent to having a brain chip embedded inside your head. Take all the time you need to think it through, but know that the future is already here: in the last two decades, neuroscientists have consistently tampered with specific structures of our brain to gauge the effect on our moral code.

"A part of the argument relies on what's called brain lateralization," James J. Hughes—associate provost for the University of Massachusetts in Boston, and executive director of the university's techno-progressive think tank, Institute for Ethics and Emerging Technologies—tells Popular Mechanics.

Brain lateralization is the view that different parts of the brain perform different functions; by turning up or turning down activity in those different sections, we can influence the way we think, feel, and behave, scientists believe. It's this property of the brain that neuromodulation, the delivery of electrical or pharmaceutical agents specifically to an area of the body to affect or change nerves, could exploit to bring about a more morally and cognitively enhanced humanity. Hughes explains this concept in-depth in a chapter in the book *Policy, Identity, and Neurotechnology: The Neuroethics of Brain-Computer Interfaces*.

We've been attempting to enhance our morality and cognition for centuries, but mostly through drugs. "Drugs like [synthetic] oxytocin increase the amount of trust we have for other people. Stimulant medications reduce fidgeting and increase our concentration on tasks. There are various studies showing drugs have moral consequences for our behavior," says Hughes. However, drugs are a bit blunt in their approach and have the tendency to affect almost every system in our body.

How Does Neuromodulation Work?

"Neuromorality" techniques could erase moral blemishes in our brains, scientists say. But is that really such a good idea?

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Neuromodulation comes with a remarkable specificity, Hughes says. “You’re only targeting the part of the brain that needs change.”

We can do this either externally, by sending electrical currents or magnetic waves directly to parts of the brain from the outside—these are transcranial direct current stimulation and transcranial magnetic stimulation techniques, respectively. Or, we can opt for more invasive brain-computer interfaces. One example is vagus-nerve stimulation, which involves implanting electrodes into the vagus nerve, the longest and most complex of the cranial nerves that is heavily involved in lowering our blood pressure and heart rate, thus moderating our “fight-or-flight” system.

Another technique is deep brain stimulation (DBS), a neurosurgical procedure that places electrodes directly in the brain. The deeper the intervention, the greater the results. “External neuromodulation can focus to a centimeter of brain tissue while DBS can create an electric cascade influencing 100,000 neurons or more,” Hughes says. (This is still not that much stimulation if you consider that the human brain contains around 100 billion neurons and 100 trillion or so interconnections between them).

Miracles have happened when lab researchers tried to increase self-control, empathy, intelligence, and even spiritual experiences inside the lab. But what happens outside experimental settings, in the unpredictability of the real world? “While valid in controlled conditions, the effect of such modulation can lessen in real-world settings, whereby the combined activation of multiple neurocognitive networks function to affect how we think and respond to various environmental cues, in particular settings and circumstances,” James Giordano, professor of neurology and neuroethics at Georgetown University Medical Center in Washington, D.C., tells Popular Mechanics.

When we modify certain traits and tendencies to fit within a socio-cultural set of standards that are regarded as “right” or “good,” we are treading on thin ice, Giordano says. “What is morally ‘good’ may be another’s reality of what is seen as harmful, disruptive, and ‘bad,’” he explains. “There is no ‘moral circuit’ or ‘moral nucleus’ that can be turned on or off. Morality is a social construct,” he says.

“The stronger your prefrontal cortex is in comparison to your amygdala, the more the fairness. You can either tell your amygdala to shut up or you can ignore the fact that your amygdala is driving your actions.”

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Hughes couldn’t agree more. How we view moral enhancement will be the central conundrum of neuromodulation as it moves forward. Some intuitions we have inherited from our evolutionary past, like “thou shalt not kill,” are here to stay. Others, like nepotism, which is the instinct to prioritize your own family over the interests of others, have been disregarded since the Enlightenment, says Hughes. “The Taliban have a totally different ethical system than NATO,” he continues. We can find more common ground if we neuromodulate not only one single virtue, but a total of six, Hughes says in his 2022 paper. These are self-control, caring, intelligence, fairness, positivity, and transcendence.

Let’s say we want to create a fairer society. Fairness is the ability to treat others impartially and justly without exhibiting favoritism or discrimination. “A person who demonstrates racial bias and shows a lot of disgust or fear is governed a lot by their amygdala,” says Hughes. The amygdala is an almond-shaped mass of gray matter inside each cerebral hemisphere, and it is the principal generator of our “fight-or-flight” response system and subsequent conditioned fear. On the contrary, behind our eyes and forehead lies the prefrontal cortex, a structure responsible for our complex cognitive behavior and moderating our own social behavior. “The stronger your prefrontal cortex is in comparison to your amygdala, the more the fairness. You can either tell your amygdala to shut up or you can ignore the fact that your amygdala is driving your actions,” says Hughes.

What Is the Worst-Case Scenario?

What happens if these sophisticated tools fall into the wrong hands? Elon Musk’s brain chip firm Neuralink could conjure some of our worst dystopian nightmares: what if hackers gained ultimate control over someone’s brain? It would be like suicide for the human mind. Likewise, what happens if a current dictator uses DBS to create a super-army of soldiers programmed to commit the wildest atrocities without an inch of regret?

“We need to ensure that the technology application is itself moral,” Beena Ammanath, executive director of the Global Deloitte AI Institute, tells Popular Mechanics. “Any mature technology ready for public adoption should come with transparency and respect for privacy and people’s consent based on a full understanding of the technology and its potential impact on them,” Ammanath says.

Hughes, meanwhile, says the debate is political. “With almost all technologies, when people worry about them being used in fascistic or

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totalitarian ways, the real problem is fascism and totalitarianism. It's not the tool," he says.

Take, for example, the Comprehensive Test Ban Treaty (CTBT) of 1996. It was signed by 172 countries, which agreed to prohibit "any nuclear weapon test explosion or any other nuclear explosion anywhere in the world." These are types of collective actions we could take to ensure our neuromoral enhancement doesn't open a Pandora's box, Hughes suggests. (Still, it is worth noting that even the CTBT needs the signatures of eight more countries to go into effect: China, Egypt, India, Iran, Israel, North Korea, Pakistan, and the United States, with the United States and China being the two greatest nuclear powers in the world).

When we decide to turn on and off the switches of our virtues control panel, we acknowledge that the self is "a useful illusion, an ensemble of various cognitive processes," says Hughes. Nihilistic? Quite the opposite.

"By stepping out of what's called the default mode network in the brain (which is the part of the brain that is associated with self-referential processes and anything related to ego), we are free to live in the moment and step out of the things that we feel certain about. We step out of the nature of reality that we feel certain about," Hughes says.

Through that lens, the robotic-sounding virtues control panel sort of becomes a tool for viewing reality in a new, fascinating light.

Popular Mechanics, 12 May 2022

<https://popularmechanics.com>

Fossil Fuels Aren't Just Harming the Planet. They're Making Us Sick

2022-05-12

For years, researchers have warned that chemical pollutants tied to fossil fuels have become so pervasive that they would be impossible for anyone to avoid.

A study released earlier this week may be the first indication of how widely some chemicals have spread. Researchers found multiple classes of potentially harmful chemicals where they've never been measured before: in the bodies of pregnant women.

Those findings have helped spur a call for policymakers to act now to protect environmental and public health from threats posed by the close

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connection between climate change and synthetic chemicals, most of which are derived from petroleum.

Scientists have known for decades that babies can be exposed to industrial chemicals even before birth because these chemicals can cross the placenta.

"To a disturbing extent, babies are born 'pre-polluted,'" scientists with the U.S. National Cancer Institute reported in 2010.

The new peer-reviewed study, published Tuesday in Environmental Science & Technology, found many chemicals that have never been measured before in pregnant women.

"We looked at chemicals from nine different classes, including things like phthalates and alternative plasticizers and pesticides and other chemicals used in personal care products," said Jessie Buckley, an associate professor of environmental health and engineering at Johns Hopkins University, "And we found that many of these chemicals were detected in all of the women in our sample from across the United States."

Buckley said she and the team selected chemicals that are in classes, such as herbicides, insecticides, parabens and phthalates, that are suspected of causing adverse health effects in mothers and children. Now that they demonstrated exposure in 171 pregnant women nationally, they are launching a second study of 6,000 women to examine if there are potential health consequences for their children.

She said they found "very widespread" exposure to neonicotinoid pesticides, newer pesticides that are replacing older pesticides of concern. Buckley said neonicotinoid pesticides, used in agriculture and in flea and tick treatments on pets, were found in the urine of almost every woman in the study.

Buckley said they also found higher concentrations of many chemicals like parabens, bisphenols and phthalates—found in things like shampoos, lotions, nail polish and water bottles—among Latina women compared to white women in the study.

"We can't tell exactly from our study why these chemicals are higher among Latino women," she said, "But we know that some personal care products and food packaging sources may be used more often among Latina women. And there's also some disparities in terms of the chemicals included in products and the kinds of products that are used that are related to inequitable exposures."

"To a disturbing extent, babies are born 'pre-polluted,'" scientists with the U.S. National Cancer Institute reported in 2010.

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Many of the chemicals they measured are analogs or replacements for chemicals that studies suggest do have health effects, Buckley said. "And these replacements are sometimes very similar to their predecessors," she said.

Jodi Flaws, a professor of comparative biosciences at University of Illinois Urbana-Champaign who was not involved in the research, said she wasn't surprised by the findings. "In fact, the recent study, as well as many previous studies, have identified chemicals in the urine from both pregnant and non-pregnant women," said Flaws. "And a lot of the chemicals that we're exposed to in the environment, we're being exposed to ubiquitously every day through many ways.

She said we know from animal studies and cell studies that a lot of the chemicals they found can interfere with the ability of the body to make hormones or respond to hormones. "And this often could lead to problems with reproduction, with development, with metabolism," she said.

Figuring out what these chemicals do to the human body is a little harder to study—and guess why. "Because we don't have controlled studies where you have a population with zero exposure because there's just different ranges of exposure," said Flaws.

And Flaws said some people are beginning to study why members of some ethnic groups are more exposed than others.

"There definitely are racial, ethnic and demographic differences and the levels of chemicals that people have," Flaws said.

She said those differences may come from multiple sources such as the use of personal care products and dietary differences. Flaws also said socioeconomic status may play a role in exposure because some of the chemicals, like phthalates, tend to be found in larger quantities in older buildings where people in poverty often live.

Flaws added: "And so there's some issues where we definitely know that these differences exist between populations, but trying to figure out why they exist, we're not sure yet."

Exceeding 'Planetary Boundaries'

U.S. production of synthetic chemicals skyrocketed since World War II, jumping more than 15-fold by 2007. Global production nearly doubled between 2000 and 2017. Petrochemicals have so pervaded the marketplace that they're now found in a seemingly endless list of plastic-

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fueled industrial and consumer products: building materials, carpets, yoga pants, fleece jackets, toys and baby products, cosmetics, fertilizers and pesticides, cars, food additives and packaging, to name a few.

And now, faced with pressure to cut back on fossil fuels, researchers said in a webinar Tuesday, oil and gas companies are ramping up production of petrochemicals and plastics.

"As fuel production decreases slightly, that increase is more than offset by the demand for plastics and petrochemicals," said Marty Mulvihill, a chemist and co-founder of Safer Made, which funds efforts to reduce human exposure to harmful chemicals.

More than 60 percent of oil demand is expected to come from plastics and chemicals in the next decade, Mulvihill said.

That shift, researchers say, is not good news for health or the climate. Both chemicals and chemical production have a "significant" carbon footprint, with chemical manufacturing accounting for 18 percent of industrial carbon emissions, Mulvihill said.

And in a dystopian feedback loop, the chemical production that releases climate-warming gases causes more pollution from industrial chemical facilities. More than 3,200 U.S. facilities that store hazardous chemicals are in areas at risk from climate-related natural disasters that include flooding, wildfire and sea level rise, according to a recent Government Accountability Office report.

"We've seen this in Louisiana, we've seen it in Houston," Mulvihill said. "After hurricanes, you have large chemical facilities, water treatment plants, other facilities near bodies of water that end up releasing large amounts of chemicals as a result of climate-exacerbated events."

Chemical pollution, like climate change, is now exceeding what researchers call a "planetary boundary," the environmental limits of Earth's capacity to recover from human assaults on natural processes, said Tracey Woodruff, director of the Environmental Research and Translation for Health (EaRTH) Center at the University of California, San Francisco.

In the United States alone, Woodruff said, the volume of industrial chemicals produced each year comes out to a minimum of 30,000 pounds per person each year.

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"It's inevitable that we are all going to be exposed to these many and varied chemicals that are being produced primarily from fossil fuel feedstock," said Woodruff.

Using natural gas components as petrochemical feedstocks is more lucrative than selling them as fuel or electricity, Woodruff said. "There's a real financial incentive to use this feedstock."

ExxonMobil, one of the largest oil and gas producers in the world, is now the biggest producer of phthalates, a petrochemical feedstock that is also a hormone-disrupting chemical found in hundreds of products from pacifiers to medical tubing in the neonatal intensive care unit. That "new car" smell? It's from phthalates.

Exxon did not respond to a request for comment.

Phthalates are a classic endocrine-disruptor, Woodruff said. Higher levels of phthalates lead to lower levels of testosterone, which is particularly important for healthy male reproductive development. Phthalate exposures can cause birth defects such as undescended testes as well as reduced sperm counts. A large and growing body of research has linked the ubiquitous chemicals to obesity, diabetes, learning problems and reduced fertility.

The American Chemistry Council did not immediately respond to a request for comment but notes on its web site that exposures to phthalates "are hundreds or thousands of times below levels of concern established by regulatory agencies."

Most of the billions of pounds of chemicals produced each year were not tested for safety before they reached the market. Yet it's clear that the vast majority of Americans are being exposed to a long list of petrochemicals and intermediate byproducts of natural gas production through studies that test samples of urine, blood, breast milk and hair.

That's because chemicals added to products don't stay in those products. They escape into the air inside our houses and accumulate in dust, seep into the ground and waterways from landfills when we throw them away and travel as far as the Arctic on air currents from the factories where they're made.

"You can get exposed to these chemicals in drinking water, in your food supply, whether it's pesticides or packaging materials," said Woodruff. "Air pollution is another important source of exposure."

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Petroleum chemistry is based on all the carbon that hasn't broken down over the last few million years, said Mulvihill. Should it surprise us that making small modifications to petroleum feedstocks produces chemicals that end up sticking around for a longer time? "The answer is no," he said.

One class of petroleum-derived chemicals called per- and polyfluoroalkyl substances, or PFAS, are so long-lived they're known as "forever chemicals." And they've contaminated drinking water supplies across the country. Yet the Environmental Protection Agency still does not regulate PFAS.

Exposure to these chemicals is not evenly distributed, starting with emissions that come from manufacturing plants, Woodruff said. "A lot of these facilities are far more heavily located in Black, brown and Indigenous communities."

Those disparities extend to chemical exposures, too. Black women, for example, have higher exposures to phthalates from chemical-laden beauty products, Woodruff said, which researchers have linked to racist marketing practices that promote European beauty norms.

Chemicals have often been in use for decades by the time researchers document their ability to harm people and wildlife. "We're seeing a rise in a number of different chronic health conditions," said Woodruff, "particularly in our more vulnerable populations, such as children."

Toward a Safer Future

Woodruff has spent decades studying how environmental pollutants harm children. The science has long been clear that regulators need to do more to protect the most vulnerable, Woodruff said in an interview. But now there's an opportunity to help consumers and policymakers understand the scope of threats from environmental exposures, she said, because the fossil fuel industry's investments in plastic production growth "will lead to us being exposed to more chemicals."

And that is likely to exacerbate health disparities in communities that are already bearing the brunt of pollution from fossil fuel extraction and production, Woodruff said.

Yet there are clear paths policymakers can follow to reduce the harms caused by fossil fuels and chemical pollution, Mulvihill and Woodruff said.

The Toxic Substances Control Act is the primary U.S. law that governs industrial chemicals in commerce. It's administered by the EPA and a

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2016 revision gives the agency “a lot of authority” to address chemicals, Woodruff said.

The agency still does not regulate chemicals as mixtures, which scientists say is critical to understanding what people are actually exposed to. But the Biden administration agreed to look at exposures of communities bordering fossil fuel facilities in conjunction with potential exposures from consumer products, Woodruff told Inside Climate News.

“They are making a nod to acknowledging that people who live in those communities will have these emissions from facilities that are going to be co-exposures along with whatever they get in their products,” Woodruff said.

“When you look at the very large universe of chemicals that we have in society, you’ll see that if we’re going to make change rapidly, we need to start grouping them together,” Mulvihill said. “And rather than trying to either understand, study, ban or replace one chemical at a time, we need to start thinking about families of chemicals.”

That means putting the brakes on what scientists call “regrettable substitution.” When it’s clear that a member of one class of chemicals is found to cause harm—like bisphenol A, another classic endocrine disruptor used to make plastic water bottles and metal can linings that’s been detected in the urine of more than 90 percent of Americans—don’t just replace it with another chemical in the same class.

Often, it’s possible to avoid hazardous chemicals altogether by simply redesigning a product. That’s what furniture manufacturers did. After decades of adding toxic flame retardants to upholstery to prevent fires from spreading, they ditched the chemicals in favor of naturally flame-resistant fabrics like wool.

For Mulvihill, the path forward is clear. “What does the future of the chemical industry look like?” he mused. You can call it green chemistry, he said, but it’s more important that whatever you call it, it does three things: protects human health, reduces environmental persistence and supports climate resilience.

“That means decoupling chemical production from petroleum production,” Mulvihill said. “That means creating chemicals that are not persistent in the environment, and creating chemicals that are, in fact, safe for human health.”

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There’s clear evidence that humans are influencing the climate of the planet and that this is directly harmful to human health, Woodruff told Inside Climate News. “Our goal,” she said, “is to provide additional data that motivates the change we need to switch our economy to something that’s focused on sustainable energy use and products.”

Inside Climate News, 12 May 2022

<https://insideclimatenews.org>

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Technical Notes

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CHEMICAL EFFECTS

[Transdermal permeation of inorganic cerium salts in intact human skin](#)

[On the Utility of ToxCast-Based Predictive Models to Evaluate Potential Metabolic Disruption by Environmental Chemicals](#)

[Environmental Exposure to Non-Persistent Endocrine Disrupting Chemicals and Endometriosis: A Systematic Review](#)

ENVIRONMENTAL RESEARCH

[Modeling and Predicting Pulmonary Tuberculosis Incidence and Its Association with Air Pollution and Meteorological Factors Using an ARIMAX Model: An Ecological Study in Ningbo of China](#)

PHARMACEUTICAL/TOXICOLOGY

[Metabolic linkages between zinc exposure and lung cancer risk: A nested case-control study](#)

[Epigenetic Inheritance: Intergenerational Effects of Pesticides and Other Endocrine Disruptors on Cancer Development](#)

OCCUPATIONAL

[The relationship between toluene diisocyanate exposure and respiratory health problems: A meta-analysis of epidemiological studies](#)

[Secondhand Smoke in the Workplace Is Associated With Depression in Korean Workers](#)

[Assessment of occupational and dietary exposures of feed handling workers to mycotoxins in rural areas from São Paulo, Brazil](#)

[Whole Body Vibration Exposure Transmitted to Drivers of Heavy Equipment Vehicles: A Comparative Case According to the Short- and Long-Term Exposure Assessment Methodologies Defined in ISO 2631-1 and ISO 2631-5](#)