

# Bulletin Board

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JAN. 27, 2023

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### ASIA PACIFIC

#### South Korea Adds 8 Reproductive Toxic Substances as “Hazardous Substances subject to Control” (Updated on Oct 18, 2022)

2022-11-28

Updates: On October 18, 2022, South Korea’s Ministry of Employment and Labor (MOEL) issued a notice to adopt the Amendments to the Standard of Occupational Safety and Health, based on the public consultation (closed in June) on the proposed changes (see below). The MoEL adopted the proposal - adding 8 reproductive toxic substances as ‘hazardous substances subject to control’, of which 7 substances are subject to special management except for cyclohexylamine.

Read More

Chemlinked, 28-11-22

<https://chemical.chemlinked.com/news/chemical-news/south-korea-consults-on-adding-eight-reproductive-toxic-substances-as-hazardous-substances-subject-to-control>

#### New Legislation To Provide Affordable Water Services For New Zealanders

2022-12-08

The Water Services Economic Efficiency and Consumer Protection Bill and Water Services Legislation Bill have been introduced to Parliament today, following the passage of the Water Services Entities Act.

Once passed the legislation will ensure affordable drinking water, wastewater and stormwater can be provided to New Zealanders now and into the future.

“These Bills are an important step in addressing a fundamental cost of living issue that will affect all New Zealanders for decades to come if left unfixed,” Local Government Minister Nanaia Mahuta said.

“Independent research shows households are looking at water costs increasing to as much as \$9,000 per year and the failure of basic water services if we do not act quickly,” Nanaia Mahuta said.

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Commerce and Consumer Affairs Minister David Clark said the Water Services Economic Efficiency and Consumer Protection Bill will ensure the future water infrastructure system provides greater service quality and consumer rights protection to all New Zealanders.

“The Government has listened closely to the feedback from councils and wider communities,” David Clark said.

“We have taken on board the desire for greater transparency by the water service entities and better water user representation by expanding the Consumer Advocacy Council’s remit so it can advocate on behalf of water services consumers.

Read More

Scoop Parliament, 08-12-22

<https://www.scoop.co.nz/stories/PA2212/S00085/new-legislation-to-provide-affordable-water-services-for-new-zealanders.htm>

### AMERICA

#### Potential SBAR Panel: Meat and Poultry Products Effluent Limitations Guidelines Rulemaking Revisions

2023-01-18

##### What is the Implication of the Proposed Rulemaking on Small Entities?

Under the Clean Water Act (CWA), EPA develops effluent limitations guidelines (ELGs) to limit pollutants discharged from industrial point source categories. EPA initially promulgated ELGs for the Meat and Poultry Products (MPP) category in 1974 and amended the regulations in 2004. The current regulation covers wastewater directly discharged by meat and poultry slaughterhouses and further processors, as well as independent renderers, but does not cover small facilities and indirect dischargers. In this rulemaking revision, EPA is considering revising and/or establishing new numeric effluent limits for direct and indirect dischargers in the MPP industry. EPA is also considering changes to the current subcategories and/or establishing additional subcategories. Potential revisions to the rulemaking may expand regulations to cover small facilities and indirect dischargers, which may impact small entities.



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Additional information is available on EPA's web site: Meat and Poultry Products Effluent Limitations Guidelines.

### What is a Small Business Advocacy Review Panel?

EPA expects to conduct a Small Business Advocacy Review (SBAR) Panel for the development of a proposed rulemaking that may impact small entities that engage in the slaughter, further processing, and/or rendering of meat and poultry, and that discharge wastewater to waters of the U.S. or to publicly owned treatment works (POTWs).

The Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act (RFA/SBREFA) requires EPA to convene an SBAR Panel unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. The Panel process offers an opportunity for small businesses, small governments, and small not-for-profit organizations (collectively referred to as small entities) to provide advice and recommendations to ensure that EPA carefully considers small entity concerns regarding the impact of the potential rule on their businesses, governments, or organizations. The Panel itself is comprised of federal employees from EPA, the Office of Management and Budget's (OMB's) Office of Information and Regulatory Affairs (OIRA), and the Office of Advocacy in the Small Business Administration (SBA). Small Entity Representatives (SERs) provide advice and recommendations to the Panel. Typically, EPA prefers that SERs be owners or operators of small businesses, small organization officials, or small government officials. Other representatives, such as trade associations that exclusively or at least primarily represent potentially regulated small entities, also may serve as SERs. These other representatives are evaluated on a case-by-case basis.

Read More

US EPA, 18-01-22

<https://www.epa.gov/reg-flex/potential-sbar-panel-meat-and-poultry-products-effluent-limitations-guidelines-rulemaking>

### Help is on the way for California truckers grappling with EV regulations

2022-12-06

Freight vehicles are one of the largest sources of air pollution in the state, and the East Bay and Central Valley are among the biggest emitters. Thirty-

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percent of the jobs in Alameda County alone are tied to industries that move goods in and out of the Port of Oakland and the Oakland airport.

While freight trucks are critical to our economy, they also threaten public health and the planet. Medium- and heavy-duty trucks make up just 7% of California vehicles, but are responsible for more than one-quarter of carbon emissions, more than 60% of smog-forming nitrogen oxides, and more than 55% of lung- and heart-harming fine particulate pollution from vehicles.

Semi-trucks are by far the biggest polluters. While they only account for 10% of trucks on the road, they are responsible for around half of all truck emissions.

Communities adjacent to freight corridors are impacted most. A recent study by UC Irvine found that deployment of zero-emission trucks will deliver critical health benefits to low-income residents who live and work closer to ports, industrial facilities and highways and experience disproportionate exposure to pollution.

Power providers are doing everything they can to help ease the transition.

While electric passenger cars are becoming more common on California roads – rising to roughly 18% of all new car sales this year – medium- and heavy-duty battery electric trucks are just starting to emerge.

Read More

CAL Matters, 06-12-22

<https://calmatters.org/commentary/2022/12/electric-vehicle-trucking-emission-regulations/>

### More 'forever chemicals' found in WA drinking water as cleanup costs mount

2022-12-11

The water pumped from the ground here was once considered pure enough to mix with a little chlorine and then pipe directly to homes.

Today, every gallon from two water district wells must first be flushed through six enormous tanks, each filled with 40,000 pounds of specially treated coal, to remove contaminants.

This pollution, known as "forever chemicals" or PFAS, can increase health risks for certain cancers and other diseases when present in drinking water



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in minuscule concentrations measured in parts per trillion. Lakewood is one of more than a dozen Washington public water systems with detections above levels defined by the state to be suitable for long-term consumption — and widespread testing is just ramping up.

Massive filtration systems can remove the contamination, but at a steep cost. Lakewood, where PFAS entered the ground from firefighting foams used at nearby Joint Base Lewis-McChord, spent \$5.5 million on its system. Through the decades, operating costs and maintenance are forecast to soak up millions of more dollars.

Read More

The Seattle Times, 11-12-22

<https://www.seattletimes.com/seattle-news/environment/more-forever-chemicals-found-in-wa-drinking-water-as-cleanup-costs-mount/>

### EPA Proposes SNURs for 35 PFAS, Advancing Key Action in PFAS Strategic Roadmap

2022-12-09

On December 2, 2022, the U.S. Environmental Protection Agency (EPA) proposed significant new use rules (SNUR) under the Toxic Substances Control Act (TSCA) for chemical substances that were the subject of premanufacture notices (PMN) and are also subject to Orders issued by EPA pursuant to TSCA. 87 Fed. Reg. 74072. The SNURs require persons who intend to manufacture (defined by statute to include import) or process any of these chemical substances for an activity that is proposed as a significant new use by this rule to notify EPA at least 90 days before commencing that activity. The required notification initiates EPA's evaluation of the use, under the conditions of use for that chemical substance, within the applicable review period. Persons may not commence manufacture or processing for the significant new use until EPA has conducted a review of the notice, made an appropriate determination on the notice, and taken such actions as are required by that determination. Comments are due January 3, 2023.

According to EPA, during review of the PMNs submitted for the chemical substances that are the subject of the proposed SNURs, EPA concluded that regulation was warranted under TSCA Section 5(e), pending the development of information sufficient to make reasoned evaluations of the health or environmental effects of the chemical substances. Based on its findings, EPA negotiated TSCA Section 5(e) Orders requiring the use of

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“appropriate exposure controls” with the PMN submitters. EPA states that as a general matter, it “believes it is necessary to follow the TSCA Orders with a SNUR that identifies the absence of those protective measures as significant new uses to ensure that all manufacturers and processors -- not just the original submitter -- are held to the same standard.” The proposed SNURs also include significant new uses that EPA proposes to determine are not ongoing based either on information showing that the chemical is not on the TSCA Inventory or based on EPA's review of Chemical Data Reporting (CDR) submissions under TSCA Section 8(a). EPA states that it “believes that these uses could significantly increase the magnitude and duration of exposure to humans and the environment to these chemical substances. Accordingly, EPA wants the opportunity to evaluate and manage risks, where appropriate, from activities associated with those uses, before manufacturing or processing for those uses were to begin.”

Read More

TSCA Blog, 09-12-22

<https://www.tscablog.com/entry/epa-proposes-snurs-for-35-pfas-advancing-key-action-in-pfas-strategic-roadm>

## EUROPE

### Proposed European PFAS ban officially submitted

2023-01-13

Today, 13 January 2023, The Netherlands, Germany, Denmark, Sweden and Norway took the first formal step towards a European ban on per- and polyfluoroalkyl substances (PFAS) by jointly submitting a restriction proposal to the European Chemicals Agency (ECHA). The restriction proposal seeks a ban on both the use and production of PFAS in order to reduce the risks these substances pose to humans and the environment. If passed, it will constitute the largest substances ban ever in Europe. The ban will also be complex, as more than 10,000 different types of PFAS exist. These are used in a multitude of products. ECHA will publish the PFAS ban proposal on 7 February.

#### Ban in three stages

There are three stages in the process of banning the use of PFAS. The first stage – the submission of a restriction proposal – was completed on 13 January 2023. This stage involved the consultation of scientific



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literature and various requests for information from relevant businesses, public authorities and organisations. The next stage, to commence after the publication of the restriction proposal (on 7 February), is a public consultation by ECHA. Anyone may submit information or state an opinion about the proposal. This information will be incorporated. Afterwards, two ECHA scientific committees – the Risk Assessment Committee (RAC) and the Socio-Economic Assessment Committee (SEAC) – will present their opinions. Finally, the European Commission will draft a definitive proposal for a Member State vote. The ban is subsequently expected to enter into force in 2025.

### PFAS harmful to humans and animals

Denmark, Germany, the Netherlands, Norway and Sweden have been working together to draft a proposal for a European PFAS ban since 2019. Many PFAS barely degrade in the environment or do not degrade at all. PFAS are known to have potentially harmful effects on human health. They can also be harmful to nature. The precise effects vary depending on the specific PFAS. One PFAS may spread faster or be more harmful than another. Furthermore, there are many PFAS about which scientists know little, if anything.

Read More

RIVM, 13-01-23

<https://www.rivm.nl/en/news/proposed-european-pfas-ban-officially-submitted>

### We can and should go further to reduce air pollution says Chief Medical Officer

2022-12-08

We can and should go further to reduce air pollution – and it is technically possible to do so, says England's Chief Medical Officer (CMO) Professor Chris Whitty, in his annual report published today (Thursday 8 December 2022).

Outdoor air pollution in England has reduced significantly since the 1980s – but it still poses significant health threats including increasing heart disease, stroke, lung disease, cancer and asthma exacerbation. It also leads to increased mortality and is associated with impacts on lung development in children.

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The report – Professor Chris Whitty's third as CMO – highlights the improvements made to outdoor air pollution and offers solutions to continue progress.

It says that indoor air pollution is becoming an increasing proportion of the overall problem as outdoor air pollution improves.

The CMO's recommendations on outdoor air pollution include:

- accelerating the electrification of light vehicles and public transport
- innovation to reduce air pollution from non-exhaust sources such as tyres, and the need for a greater range of options for reducing air pollution from heavy and specialised vehicles
- local urban planning should support reducing air pollution locally – such as reducing air pollution near schools and healthcare settings
- in agriculture, ammonia air pollution emissions could be reduced through modified farming practices, such as applying slurry directly to soil
- the NHS has committed to halving its contribution to poor air quality within a decade

Read More

Gov.uk, 08-12-22

<https://www.gov.uk/government/news/we-can-and-should-go-further-to-reduce-air-pollution-says-chief-medical-officer>

### Due to Risk of Liver Damage, EU Limits Green Tea Extract with EGCG in Foods

2022-12-07

New EU legislation restricts the amount of green tea extract containing (-)-epigallocatechin-3-gallate (EGCG) that can be present in food and sets new labeling requirements. EGCG is a catechin, which are flavinols that may lead to liver damage.

Catechins, of which EGCG is the most common type, are found naturally in the leaves of *Camellia sinensis* (L.) Kuntze, the plant that is processed into green tea. A 2018 scientific opinion from the European Food Safety Authority (EFSA) concluded that consumption of EGCG exceeding 800 milligrams per day (mg/day) may increase the likelihood of liver damage when taken as a food supplement. EFSA's determination was based on studies that revealed a statistically significant increase of serum

**The wide-ranging report on air pollution makes 15 recommendations across a range of sectors, including transport, urban planning, industry and agriculture.**



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transaminases, which are indicative of liver injury, in subjects given EGCG supplements.

Despite containing EGCG, it is considered generally safe to consume catechins from traditionally prepared green tea infusions and reconstituted drinks with an equivalent composition. Among the adult population in the EU, the mean daily intake of EGCG from the consumption of green tea infusions ranges from 90–300 mg/day, while those who ingest EGCG supplemented products may consume an estimated 866 mg EGCG/day. Food supplements containing green tea catechins provide a daily dose of EGCG in the range of 5–1,000 mg/day, according to EFSA.

In its opinion, EFSA could not provide advice on a dietary intake of green tea catechins due to the varied chemical composition of catechins, including EGCG, affected by plant variety, growing conditions, and other factors. Additionally, there are uncertainties on how the composition of extracted catechins and other substances used to prepare green tea extracts is influenced by manufacturing procedures.

Based on EFSA's opinion, the European Commission amended Annex III of Regulation (EC) No 1925/2006 to establish new limits for EGCG in foods. The legislation suggests a daily intake level of EGCG from green tea extracts at 800 mg/day, but recommends studies be conducted to determine a dose-response of hepatotoxicity of green tea catechins, and examine inter- and intra-species variability. The compound will be further reviewed within the EU, and the permitted daily dose may be changed within four years.

Read More

Food Safety Magazine, 07-12-22

<https://www.food-safety.com/articles/8187-due-to-risk-of-liver-damage-eu-limits-green-tea-extract-with-egcg-in-foods>

### Ranked: Research reveals which European country has the most eco-conscious shoppers

2022-12-07

From mending your old clothes to buying local produce, there are plenty of ways to shop sustainably.

Doing so is an environmental imperative - the fashion industry is responsible for more than 10 per cent of carbon emissions and consumes

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approximately 100 million tonnes of oil every year. Around a third of the world's food ends up rotting in landfill before it can be eaten.

Thankfully, consumption habits are shifting.

A new study has ranked Europe's 30 most populous countries on their environmental shopping habits.

"Once viewed as an option for hipsters, [sustainable shopping] is now a viable and environmentally-friendly way to shop for people of all ages and income brackets," the report - by online fundraising platform Savoo - reads.

### Which European country has the most sustainable shoppers?

To calculate an overall 'sustainability score,' researchers ranked countries on a number of different metrics.

They included recycling rates and consumption footprint - the size of the area needed to produce the materials a country consumes, combined with the area needed to absorb its subsequent waste.

The number of 'flea markets and antique stores' also factored in, as did the amount of textile waste and per capita household waste.

Finally, the analysts considered a country's sustainable development goals (SDG) ranking, a United Nations-issued score analysing national performance on development goals like climate action and renewable energy promotion.

Overall, they ranked Finland in the top spot. This is largely because of its excellent SDG score, at the top of all 193 UN member states.

The Scandinavian country also reduced its consumption footprint by more than a fifth between 2010 and 2020.

On the other end of the spectrum, Malta ranked as the worst country for sustainable shopping.

The small island nation had the lowest SDG score of any country on the list, and increased its consumption footprint by 10.5 per cent between 2010 and 2020.

Read More

Euronews.green, 07-12-22

<https://www.euronews.com/green/2022/12/07/ranked-research-reveals-which-european-country-has-the-most-eco-conscious-shoppers>



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### European General Court Annuls Harmonized Classification and Labeling of Titanium Dioxide

2022-12-06

On November 23, 2022, the Court of Justice of the European Union (EU) announced a decision of the General Court that annuls the 2019 harmonized classification and labeling of titanium dioxide as a carcinogenic substance by inhalation in certain powder forms. According to the press release, the European Commission (EC) “made a manifest error in its assessment of the reliability and acceptability of the study on which the classification was based and, second, it infringed the criterion according to which that classification can relate only to a substance that has the intrinsic property to cause cancer.”

#### Background

In 2016, the competent French authority submitted a proposal to the European Chemicals Agency (ECHA) to classify titanium dioxide as a category 1B carcinogenic substance (carcinogenic to humans). In 2017, ECHA’s Committee for Risk Assessment (RAC) adopted an opinion classifying titanium dioxide as a category 2 carcinogen (suspected human carcinogen), including the hazard statement “H 351 (inhalation).” On the basis of RAC’s Opinion, the EC adopted Regulation 2020/217, implementing the harmonized classification and labeling of titanium dioxide, recognizing that that substance was suspected of being carcinogenic to humans, by inhalation, in powder form containing one percent or more of particles of a diameter equal to or less than ten micrometers ( $\mu\text{m}$ ). The transition period for adoption of these changes ended October 1, 2021. The applicants, in their capacity as manufacturers, importers, downstream users, or suppliers of titanium dioxide, brought actions before the General Court for the partial annulment of Regulation 2020/217.

#### Findings of the Court

The General Court held that the requirement to base the classification of a carcinogenic substance on reliable and acceptable studies was not satisfied. According to the press release, in recognizing that the results of a scientific study on which it based its opinion on the classification and labeling of titanium dioxide were sufficiently reliable, relevant, and adequate for assessing the carcinogenic potential of that substance, RAC committed “a manifest error of assessment.” Specifically, to verify the degree of lung overload of titanium dioxide particles in that scientific

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study to assess carcinogenicity, RAC used a density value corresponding to the density of unagglomerated primary particles of titanium dioxide, “which is always higher than the density of the agglomerates of nano-sized particles of that substance.” The press release states that in so doing, RAC did not take into account all the relevant factors to calculate the lung overload during the scientific study at issue, namely the characteristics of the particles tested in that scientific study, the fact that those particles tend to agglomerate, and the fact that the density of the agglomerates of particles was lower than the particle density and that, for that reason, those agglomerates occupied more volume in the lungs. Thus, according to the General Court, RAC’s findings that the lung overload in the scientific study at issue was acceptable were implausible. Consequently, when the EC based the contested regulation and the harmonized classification and labeling of titanium dioxide on the RAC Opinion, thus following RAC’s conclusion as to the reliability and acceptability of the results of the scientific study at issue, “it made the same manifest error of assessment as the RAC.”

The General Court found that the contested classification and labeling “infringed the criterion according to which the classification of a substance as carcinogenic can apply only to a substance that has the intrinsic property to cause cancer.” Under Regulation (EC) No 1272/2008, harmonized classification and labeling of a substance as carcinogenic may be based only on the intrinsic properties of the substance that determine its intrinsic capacity to cause cancer. The General Court interpreted the concept of “intrinsic properties,” stating that, although that concept does not appear in Regulation (EC) No 1272/2008, “it must be interpreted in its literal sense as referring to the ‘properties which a substance has in and of itself,’ which is consistent, inter alia, with the objectives and purpose of harmonised classification and labelling under that regulation.” The General Court notes that the contested classification and labeling are intended to identify and notify a carcinogenic hazard of titanium dioxide, which, in the RAC Opinion, was classified as “non-intrinsic in a classical sense.” According to the press release, the General Court states that that “non-intrinsic in the classical sense” nature stems from several factors, referred to both in that opinion and in the contested regulation. The carcinogenicity hazard is linked solely to certain respirable titanium dioxide particles when they are present in a certain form, physical state, size, and quantity; it occurs only in lung overload conditions; and corresponds to particle toxicity.

The General Court concluded that, by upholding the conclusion contained in the RAC Opinion that the mode of action of carcinogenicity on which



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RAC relied could not be regarded as intrinsic toxicity in the classical sense, but which had to be taken into consideration in the context of harmonized classification and labeling under Regulation (EC) No 1272/2008, the EC committed a manifest error of assessment. According to the press release, the General Court states that the examples of classification and labeling of other substances, relied on to compare them with the classification and labeling of titanium dioxide, “illustrate only cases in which, even though the form and size of the particles were taken into account, certain properties specific to the substances were nevertheless decisive for their classification, which does not correspond to the case here.”

Read More

Bergeson & Campbell PC, 06-12-22

<https://www.lexology.com/library/detail.aspx?g=eb208d7c-10cb-4391-bcaa-38f82d6ea89d>

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## REACH Update

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### **ECHA adds nine hazardous chemicals to Candidate List**

2023-01-17

The Candidate List of substances of very high concern now contains 233 entries for chemicals that can harm people or the environment. Companies are responsible for managing the risks of these chemicals and must also give their customers and consumers information to use them safely.

Helsinki, 17 January 2023 - ECHA has added nine chemicals to the Candidate List because of their hazardous properties. They are used for example in flame retardants, paints and coatings, inks and toners, coating products, plasticisers and in the manufacture of pulp and paper.

Read More

ECHA, 17-01-2023

<https://echa.europa.eu/-/echa-adds-nine-hazardous-chemicals-to-candidate-list>

### **ECHA receives PFASs restriction proposal from five national authorities**

2023-01-13

The national authorities of Denmark, Germany, the Netherlands, Norway and Sweden have submitted a proposal to ECHA to restrict per- and polyfluoroalkyl substances (PFASs) under REACH, the European Union's (EU) chemicals regulation. ECHA will publish the detailed proposal, one of the broadest in the EU's history, on 7 February 2023.

Helsinki, 13 January 2023 – The restriction proposal comes after the five authorities found risks in the manufacture, placement on the market and use of PFASs that are not adequately controlled and need to be addressed throughout the EU and the European Economic Area.

ECHA will run the required administrative checks before the proposed restriction and supporting documents are made available on 7 February 2023. On the same day, the national authorities will host a hybrid media event in Brussels from 11:00 to 12:30 (CET). An info session for industry, NGOs and other stakeholders will take place later.

Over the past three years, the five national authorities have investigated different PFASs, their uses and the risks they may pose to people and the



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environment. They held two public consultations to gather evidence on the use of these substances and examined all information received.

### Next steps

ECHA's scientific committees for Risk Assessment (RAC) and for Socio-Economic Analysis (SEAC) will check that the proposed restriction meets the legal requirements of REACH in their meetings in March 2023. If it does, the committees will begin their scientific evaluation of the proposal.

A six-month consultation is planned to start on 22 March 2023. An online information session will be organised on 5 April 2023 to explain the restriction process and help those interested in participating in the consultation.

The opinions of RAC and SEAC are normally ready within 12 months of the start of the scientific evaluation, in accordance with REACH. However, in view of the complexity of the proposal and the extent of information that is expected from the consultation, the committees may need more time to finalise their opinions.

Once the opinions are adopted, they are sent to the European Commission, who together with the EU Member States will then decide on a potential restriction.

### Read More

ECHA, 13-01-23

<https://echa.europa.eu/-/echa-receives-pfass-restriction-proposal-from-five-national-authorities>

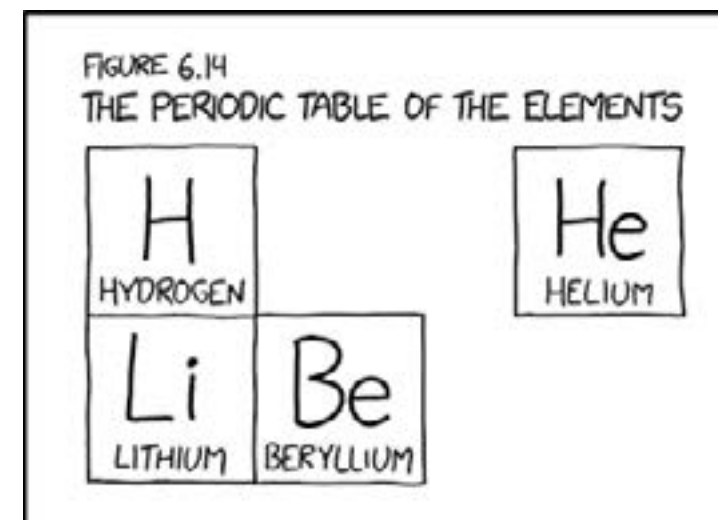
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## Janet's Corner

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### Outdated Periodic Table

2023-01-27



YOU CAN SPOT AN OUTDATED SCIENCE TEXTBOOK BY CHECKING THE BOTTOM OF THE PERIODIC TABLE FOR MISSING ELEMENTS. FOR EXAMPLE, MINE WAS PUBLISHED HALF AN HOUR AFTER THE BIG BANG.

<https://xkcd.com/2723/>



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## Hazard Alert

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### n-Hexane

2017-03-06

Hexane is an alkane of six carbon atoms, with the chemical formula  $C_6H_{14}$ . There are 5 hexane isomers; n-hexane is the unbranched isomer. [1]

n-Hexane is a chemical made from crude oil. Pure n-hexane is a colourless liquid with a slightly disagreeable odour. It evaporates very easily into the air and dissolves only slightly in water. n-Hexane is highly flammable, and its vapours can be explosive. [2]

### USES [3]

It is used in laboratories, primarily when it is mixed with similar chemicals to produce solvents. Common names for these solvents are commercial hexane, mixed hexanes, petroleum ether, and petroleum naphtha. The major use for solvents containing n-hexane is to extract vegetable oils from crops such as soybeans, flax, peanuts, and safflower seed. They are also used as cleaning agents in the textile, furniture, shoemaking, and printing industries, particularly rotogravure printing. N-hexane is also an ingredient of special glues that are used in the roofing, shoe, and leather industries. n-Hexane is used in binding books, working leather, shaping pills and tablets, canning, manufacturing tires, and making baseballs.

### SOURCES OF EMISSION & ROUTES OF EXPOSURE

#### Sources of Emission [3]

- Industry sources: Releases from industries producing, using or handling hexane. For example, rubber and plastics products industries, oil refineries, chemical plants, footwear manufacturing, petrol, and paints and adhesives.
- Diffuse sources: Releases from service stations; evaporation of fuels during petrol refilling; underground storage tanks that leak. Releases during use of adhesives, paints, and paint thinners.
- Natural sources: Hexane is a natural constituent of crude petroleum. It also occurs naturally as a plant volatile and can be released from volcanoes. Furthermore, n-hexane occurs naturally in, forest fires, and some plants.
- Transport sources: Vehicle exhaust. Evaporation of vehicle fuels from motors and vehicle fuel tanks.
- Consumer products: Consumer products that contain small amounts of n-hexane include petrol, rubber cement, type-over correction

**Hexane is an alkane of six carbon atoms, with the chemical formula  $C_6H_{14}$ .**

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fluids, non-mercury (low temperature) thermometers, alcohol preparations, and aerosols in perfumes. n-Hexane is also a component of preparations such as paint thinners, general-purpose solvents, degreasing agents, and cleaners.

### Routes of Exposure [3,4]

n-Hexane evaporates very quickly and so the most common exposure is from breathing air-containing hexane. It can also enter via the skin. The most probable route of human exposure to hexane is by inhalation. Since it is in gasoline, nearly everyone is exposed to very small amounts of n-hexane in the air. Exposure can occur at home if you use products containing n-hexane without proper ventilation. Individuals are most likely to be exposed to hexane in the workplace. Monitoring data indicate that hexane is a widely occurring atmospheric pollutant.

### HEALTH EFFECTS

#### Acute Effects

- Acute inhalation exposure of humans to high levels of hexane causes mild CNS depression. CNS effects include dizziness, giddiness, slight nausea, and headache in humans.
- Acute exposure to hexane vapours may cause dermatitis and irritation of the eyes and throat in humans.
- Acute animal tests in rats have demonstrated hexane to have low acute toxicity from inhalation and ingestion exposure.

#### Chronic Effects

- Chronic inhalation exposure to hexane is associated with sensorimotor polyneuropathy in humans, with numbness in the extremities, muscular weakness, blurred vision, headache, and fatigue observed.
- Rats, chronically exposed by inhalation, have exhibited neurotoxic effects.
- Mild inflammatory, erosive, and degenerative lesions in the olfactory and respiratory epithelium of the nasal cavity have been observed in mice chronically exposed by inhalation. Pulmonary lesions have also been observed in chronically exposed rabbits.
- The Reference Concentration (RfC) for hexane is 0.2 milligrams per cubic metre ( $mg/m^3$ ) based on neurotoxicity in humans and epithelial lesions in the nasal cavity in mice.
- EPA has not established a Reference Dose (RfD) for hexane.



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- EPA has calculated a provisional RfD of 0.06 milligrams per kilogram body weight per day (mg/kg/d) based on neurological and reproductive effects in rats.

### Reproductive/Developmental Effects

- No information is available on the reproductive or developmental effects of hexane in humans.
- Testicular damage has been observed in male rats exposed to hexane via inhalation.
- Teratogenic effects were not observed in the offspring of rats chronically exposed via inhalation in several studies.

### Cancer Risk

- No information is available on the carcinogenic effects of hexane in humans or animals.
- EPA has classified hexane as a Group D, not classifiable as to human carcinogenicity, based on a lack of data concerning carcinogenicity in humans and animals. (3,5)

### SAFETY [6]

#### First Aid Measures

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

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Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

### Fire and Explosion Information

- n-Hexane is flammable.
- Auto-ignition temperature is 225°C (437°F)
- Flash Points: CLOSED CUP: -22.5°C (-8.5°F).
- Carbon monoxide (CO) and carbon dioxide (CO<sub>2</sub>) are produced upon combustion.
- Highly flammable in presence of open flames and sparks, of heat.
- Non-flammable in presence of shocks.
- n-hexane is a flammable liquid that is insoluble in water.
- Dry chemical powder should be used to extinguish small fires.
- Water spray or fog should be used to extinguish large fires.
- Special Remarks on Fire Hazards: Extremely flammable liquid and vapour. Vapour may cause flash fire.

### Exposure Controls & Personal Protection

#### Engineering Controls

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

#### Personal Protective Equipment

The following personal protective equipment is recommended when handling n-hexane:

- Safety glasses;
- Lab coat;
- Vapour respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves (impervious).

Personal Protection in Case of a Large Spill:

- Splash goggles;
- Full suit;
- Vapour respirator;



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- Boots;
- Gloves;
- A self-contained breathing apparatus should be used to avoid inhalation of the product.
- Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

### REGULATION

#### United States [4,7]

NIOSH: The National Institute of Occupational Safety and Health has established a Recommended Exposure Limit (REL) of no more than 50 parts per million (ppm) in workplace air or 180 mg/m<sup>3</sup>.

OSHA: The Occupational Health and Safety Administration has set a Permissible Exposure Limit of 500 ppm for n-hexane in workplace air or 1800 mg/m<sup>3</sup>.

EPA: The Environmental Protection Agency requires that spills or accidental releases of 5,000 pounds or more of n-hexane be reported to the EPA.

#### Australia [3]

Safe Work Australia has set a maximum 8-hour time weighted average (TWA) exposure for n-hexane of 176 mg/m<sup>3</sup>.

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Scientists Warn That UV-Emitting Nail Polish Dryers Damage Human DNA and Cause Mutations

2023-01-20

The ultraviolet nail polish drying devices used to cure gel manicures may pose more of a public health concern than previously thought. Researchers at the University of California San Diego studied these ultraviolet (UV) light-emitting devices, and found that their use leads to cell death and cancer-causing mutations in human cells.

The devices are a common fixture in nail salons, and generally use a particular spectrum of UV light (340-395nm) to cure the chemicals used in gel manicures. While tanning beds use a different spectrum of UV light (280-400nm) that studies have conclusively proven to be carcinogenic, the spectrum used in the nail dryers has not been well studied.

"If you look at the way these devices are presented, they are marketed as safe, with nothing to be concerned about," said Ludmil Alexandrov, a professor of bioengineering as well as cellular and molecular medicine at UC San Diego, and corresponding author of the study published on January 17 in the journal Nature Communications. "But to the best of our knowledge, no one has actually studied these devices and how they affect human cells at the molecular and cellular levels until now."

Using three different cell lines— adult human skin keratinocytes, human foreskin fibroblasts, and mouse embryonic fibroblasts— the researchers found that the use of these UV emitting devices for just one 20-minute session led to between 20 and 30 percent cell death, while three consecutive 20-minute exposures caused between 65 and 70 percent of the exposed cells to die.

Exposure to the UV light also caused mitochondrial and DNA damage in the remaining cells and resulted in mutations with patterns that can be observed in skin cancer in humans.

"We saw multiple things: first, we saw that DNA gets damaged," said Alexandrov. "We also saw that some of the DNA damage does not get repaired over time, and it does lead to mutations after every exposure with a UV-nail polish dryer. Lastly, we saw that exposure may cause mitochondrial dysfunction, which may also result in additional mutations. We looked at patients with skin cancers, and we see the exact same patterns of mutations in these patients that were seen in the irradiated cells."

**The DNA damage does not get repaired over time, and it does lead to mutations after every exposure with a UV-nail polish dryer.**



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The researchers caution that, while the results show the harmful effects of the repeated use of these devices on human cells, a long-term epidemiological study would be required before stating conclusively that using these machines leads to an increased risk of skin cancers. However, the results of the study were clear: the chronic use of these nail polish drying machines is damaging to human cells.

Maria Zhivagui, a postdoctoral scholar in the Alexandrov Lab and first author of the study, used to be a fan of gel manicures herself, but has sworn off the technique after seeing the results.

“When I was doing my PhD, I started hearing about gel manicures, which last longer than normal polish. I was interested in trying out gel nail polish, particularly in the setting of working in an experimental lab where I frequently put gloves on and off, to maintain a presentable appearance,” said Zhivagui. “So I started using gel manicures periodically for several years. Once I saw the effect of radiation emitted by the gel polish drying device on cell death and that it actually mutates cells even after just one 20-minute session, I was surprised. I found this to be very alarming, and decided to stop using it.”

### Studying their effect on human cells

The idea to study these particular devices came to Alexandrov in a dentist’s office, of all places. As he waited to be seen, he read a magazine article about a young beauty pageant contestant who was diagnosed with a rare form of skin cancer on her finger.

“I thought that was odd, so we began looking into it, and noticed a number of reports in medical journals saying that people who get gel manicures very frequently– like pageant contestants and estheticians– are reporting cases of very rare cancers in the fingers, suggesting that this may be something that causes this type of cancer,” said Alexandrov. “And what we saw was that there was zero molecular understanding of what these devices were doing to human cells.”

To conduct the study, Zhivagui exposed the three cell types to two different conditions: acute exposure and chronic exposure to the UV light device. Under acute exposure, Petri dishes containing one of the cell types were placed in one of these UV curing machines for a 20-minute session. They were then taken out for an hour to repair or return to their steady state, and then given one more 20-minute exposure. Under chronic exposure, the cells were placed under the machine for 20 minutes a day for three days.

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Cell death, damage and DNA mutations were seen under both conditions, with an elevation of reactive oxygen species molecules– known to cause DNA damage and mutations– and mitochondrial dysfunction in the cells. Genomic profiling revealed higher levels of somatic mutations in the irradiated cells, with patterns of mutations ubiquitously present in melanoma patients.

### Is the risk worth the reward?

This data in human cells, coupled with a number of prior reports of cancers in people who get gel manicures very frequently, paint a picture of a purely cosmetic procedure that is riskier than previously believed. But is getting a gel manicure once a year really cause for concern, or should only those who get this done on a very regular basis be worried? Further studies are needed to quantify any increased risk of cancer and at what frequency of use, but with plenty of alternatives to this cosmetic procedure, the risk may not be worth it to some consumers.

“Our experimental results and the prior evidence strongly suggest that radiation emitted by UV-nail polish dryers may cause cancers of the hand and that UV-nail polish dryers, similar to tanning beds, may increase the risk of early-onset skin cancer,” they write. “Nevertheless, future large-scale epidemiological studies are warranted to accurately quantify the risk for skin cancer of the hand in people regularly using UV-nail polish dryers. It is likely that such studies will take at least a decade to complete and to subsequently inform the general public.”

Though other consumer products use UV light in the same spectrum– including the tool used to cure dental fillings and some hair removal treatments– the researchers note that the regularity of use, plus the entirely cosmetic nature of nail dryers, sets them apart.

Sci Tech Daily, 20 January 2023

<https://scitechdaily.com>

### Magnets key to removing dangerous PFAS chemicals

2023-01-20

Queensland researchers have developed a way to quickly and simply remove dangerous PFAS chemicals from water using magnets.

Researchers from the University of Queensland have developed a method that does not require electricity or bulky lab equipment.



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PFAS (perfluorinated and polyfluorinated alkyl substances) had been used extensively since the 1950s in a variety of forms, including in firefighting foam used at airports as well as in consumer products such as non-stick frying pans.

They are now believed to cause cancers and other illnesses, and are known as a “forever chemical” due to their tendency to remain in the environment without breaking down.

While they are no longer used, methods to remove them from local environments have been needed, especially where drinking water supplies have been contaminated.

Polymer chemist Dr Cheng Zhang and PhD candidate Xiao Tan at UQ’s Australian Institute for Bioengineering and Nanotechnology have spearheaded a way to quickly and easily remove the PFAS from water.

They use what is called a magnetic fluorinated polymer sorbent, which binds to the PFAS in the water.

“Because it has a magnetic element, we then simply remove the sorbent, and the PFAS along with it, using a simple magnet,” Zhang said.

The process is quicker than 30 seconds and removes over 95 per cent of the PFAS in the water sample.

Current methods for removing PFAS from water involve carbon filters and while they are also above 90 per cent effective, they can take up to 30 hours to remove the contamination and require bulky equipment, Zhang said.

The UQ developed method is also reusable up to 10 times.

Zhang said they were now working on scaling up the process from lab-based work to something that could be used in individual homes and on larger scales.

“We hope to have a commercially available product ready in the next three years,” he said. “Something you could buy from a supermarket in the same way that a lot of other water filtration products are available.”

The research received funding from the Australian Research Council, the National Health and Medical Research Council, The Chemours Company and the US Department of Defense.

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Serious PFAS contamination has been recorded at a number of locations around Australia, including near defence bases at Oakey and Amberley in Queensland and Darwin and Katherine in the Northern Territory.

A number of lawsuits have been launched over the contamination, and the government is finalising a National Environmental Management Plan for PFAS.

The UQ research has been published in the journal *Angewandte Chemie*.

The Age, 20 January 2023

<https://theage.com.au>

### Bioengineered “superplant” could soon be purifying the air in your home

2023-01-18

We’ve all heard how it’s a good idea to have plants in your home, as they help purify the air. Well, the bioengineered Neo P1 is claimed to excel in that department, as it’s reportedly equivalent to up to 30 regular houseplants in terms of air purification.

Created by Paris-based biotech startup Neoplants, the Neo P1 is actually a genetically engineered type of pothos, a plant which is already known to be good at removing volatile organic compounds (VOCs) from the air.

The Neo P1 has been specifically designed to capture large amounts of four of the most toxic VOCs, namely formaldehyde, benzene, toluene and xylene. Genes added to its DNA cause it to produce enzymes which convert those compounds into harmless substances that are used by the plant. More specifically, formaldehyde is converted into fructose, while benzene, toluene and xylene are converted into an amino acid.

That being said, the Neo P1 does get a bit of help.

It comes with its own special soil which contains biochar, a charcoal-like material that is produced by heating biomass in an oxygen-free environment. Among other things, the biochar provides a home for beneficial microorganisms which are added to the soil once a month, in supplements known as Power Drops.

These microbes receive life-sustaining nutrients from the plant while simultaneously boosting its air purification performance – they also do some VOC-capturing of their own, as air flows through the soil via slots

**The method is quicker and easier than existing decontamination methods which can take over a day to remove PFAS.**

**It’s reportedly equivalent to up to 30 regular houseplants in terms of air purification.**



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in the supplied pot. We're told that the plant-to-soil air purification ratio varies depending on the size of the plant, but that it should be about a 50:50 split once the Neo P1 reaches maturity.

Apart from adding the Power Drops, watering is the only required maintenance. Thanks to a reservoir in the pot, this reportedly only needs to be done once a month in the winter, and once every two weeks in the summer.

Users definitely will want to stay on top of that maintenance, though, as the Neo P1 should ultimately sell for a whopping US\$179 a pop. That price includes three Power Drops – the cost of “refill” drops has yet to be determined.

So, why not just buy an electric air purifier that doesn't need sunlight, water or microbes?

“Air purifiers do a great job of capturing particulate matter (smoke from fires, for example), but it's much more challenging to capture VOCs, which also cause significant health problems – most purifiers fail at doing this,” Neoplants CEO Lionel Mora told us. “You buy a plant because it's a beautiful living thing in your home that serves many purposes that an air purifier cannot. Not to mention that plants require zero electricity and make no noise. It also works 24/7.”

New Atlas, 18 January 2023

<https://newatlas.com>

### **‘Advanced’ Recycling of Plastic Using High Heat and Chemicals Is Costly and Environmentally Problematic, A New Government Study Finds**

2023-01-19

The plastics industry's quest to solve the problem of plastic waste through so-called “advanced” recycling—using chemical additives and sometimes extremely high heat to turn waste back into new plastics—is costly and comes with significant environmental impacts, according to new research from the federal government's National Renewable Energy Lab in Colorado.

Government researchers singled out two prominent “advanced” technologies—pyrolysis and gasification—as particularly problematic, saying they should not even be considered “closed-loop” recycling

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technologies. These technologies require large amounts of energy and emit significant pollutants and greenhouse gases to turn discarded plastics into oil or fuel, or chemicals such as benzene, toluene and xylene, synthetic gases and a carbon char waste product.

So far, 21 states have enacted laws sought by the U.S. plastics industry that categorize advanced plastics recycling as a manufacturing process and not waste disposal. But environmentalists say using plastic waste to make new fossil fuels or feedstocks for more plastic further damages the environment and worsens climate change.

Other forms of chemical recycling fared better than pyrolysis and gasification in the new research, but the more traditional method of recycling—using mechanical means to sort, clean, shred and remold waste plastic—performed better on economic and environmental parameters than emerging methods, although it still has technical limitations, the researchers found.

Taken together, the peer-reviewed study by a 12-member Department of Energy team that examined the benefits and trade-offs of current and emerging technologies for recycling illustrates the major challenges ahead as the world seeks ways to handle the 400 million metric tons of plastic waste generated globally each year.

Mankind is producing twice as much plastic waste as two decades ago, with the bulk of it dumped in landfills, burned by incinerators or littered across the environment, with only 9 percent recycled, according to a report last year from the Organization for Economic Cooperation and Development, a group that represents developed nations.

“There's a lot of work around plastics and it's very much a hot topic,” said research analyst Taylor Uekert, the lead author of the new study, “Technical, Economic, and Environmental Comparison of Closed-Loop Recycling Technologies for Common Plastics,” published Jan. 12 in the American Chemical Society's peer-reviewed journal, Sustainable Chemistry & Engineering. “The inspiration here was really to look at all of these different up-and-coming recycling technologies and figure out how they stack up on a consistent basis on environmental, economic and technical perspectives.”

Experts say plastic was never designed to be recycled. It is made of polymer chains and chemical additives, many of them toxic, meant to give the material different properties, such as flexibility, texture, clarity and color. The varied chemical nature of plastic waste, much of which gets

**Industry is pursuing various technologies to help solve the global plastic waste problem, but environmentalists say new recycling techniques only make environmental problems worse.**



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mixed together after it is used once for a few minutes, only adds to the challenge of recycling.

The researchers studied several kinds of chemical recycling, focusing on those that could legitimately be considered “closed loop” solutions, in which plastic waste is turned into feedstock to make new plastics.

Among those were technologies that use solvents, enzymes, acids or methanol to break down plastic into its chemical building blocks. They also examined different kinds of plastics, including high- and low-density polyethylene (HDPE and LDPE), polyethylene terephthalate (PET), and polypropylene (PP).

With the exception of mechanical recycling, the technologies that the team evaluated are mostly in early development, including some with pilot projects, Uekert said.

The chemical industry has been pushing for regulatory changes at the state and federal level that would encourage pyrolysis or gasification or relax clean-air requirements. The Environmental Protection Agency describes pyrolysis and gasification as heat-induced thermal decomposition processes, although gasification uses some oxygen.

Some industry proposals have faced strong pushback locally and from national environmental groups, including a troubled new chemical recycling plant in Ashley, Indiana, a proposed plant in Point Township, Pennsylvania, and a proposed trash-and-plastic waste-to-jet fuel plant in Gary, Indiana.

U.N. diplomats are also debating the role of chemical recycling as part of an existing hazardous waste treaty, with implications for a proposed global treaty on plastic waste, as the chemical industry lobbies for chemical recycling as part of a “circular economy,” another term for closed loop.

But when it comes to pyrolysis and gasification, each dependent upon a lot of energy and heat, the NREL researchers did not even consider them to be closed-loop solutions since typically they turn plastics into fuel or other chemical feedstocks, not new plastic.

With pyrolysis and gasification, much of the waste plastic is lost in the process, which critics have said makes it hard to describe those processes as recycling. In fact, the researchers found only 1 to 14 percent of the plastic sent through those processes is retained as plastic.

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Other methods of chemical recycling do a better job of preventing such losses, with plastic retention rates of 54 percent to 95 percent, the researchers found. For example, researchers found that a chemical process that used ethylene glycol to break down and recycle PET plastic had a more favorable economic and environmental performance than other chemical recycling methods.

The economic and environmental metrics of pyrolysis and gasification are currently ten to 100 times higher—or worse—compared to using virgin polymers to make plastic, the researchers found.

Mechanical recycling, with its lower operational and capital costs, economically outcompetes all other recycling options at a statistically significant level, according to the researchers.

Reports have similarly shown that mechanical recycling has lower greenhouse gas emissions than chemical recycling, landfilling or incineration, the researchers noted.

Still, mechanical recycling is faced with significant technical challenges, including the mixed nature of the supply of plastic waste.

“If you have any sort of contaminants coming in, it’s just going to be melted back into your plastic and that means your quality is going to be lower,” Uekert said.

That leaves potential room for some chemical recycling options in the future, including the one using ethylene glycol, she said.

“I think there’s a lot of room for combining multiple recycling options,” she said, such as mechanically recycling “the more pure streams” of waste plastic and “sending the more contaminant stuff to one of the chemical recycling options.”

While the researchers evaluated the science of recycling options, some environmental groups are focusing on the reduction of plastic manufacturing and plastic use, and fighting the chemical industry’s push for chemical recycling.

“We call that false recycling,” Judith Enck, the founder and president of the environmental group Beyond Plastics, said during a webinar on plastics and health last week. “I am a huge fan of recycling but plastics recycling has been an abysmal failure. We focus on reducing the production, use and generation of plastics and not plastics recycling. We



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are highly motivated to do that because of the health concerns" of plastic production, use and disposal, she said.

A study her group did last year found that plastics recycling in the United States had fallen to below 6 percent.

Matthew Kastner, a spokesman for the American Chemistry Council's plastics division, described the report as "meaty," adding that the council needs more time to analyze the research before commenting.

"Generally speaking though, ACC views mechanical and chemical recycling technologies to be complementary to each other," he said. "If used plastic can be mechanically recycled, it should be. If it isn't suitable for mechanical recycling but is suitable for chemical recycling, then it should be chemically recycled."

On Thursday, Kastner said the study did not reflect the current state of pyrolysis and gasification, which the industry has been pursuing along with other forms of advanced recycling.

"In the past five years nearly \$7 billion in investments in advanced recycling have been announced or already operating, with a predicted ability to divert over 15 billion pounds of plastics from landfills annually," he said. "These investments and technological improvements are already recycling plastic that's used in over 60 products around the globe, and helping scale up a circular economy for hard-to-recycle plastics to be remade over and over again."

Eukert said the study gives recyclers and policymakers a tool for evaluating the costs and benefits of each method.

"We know cost is one of the primary drivers for recycling for companies wanting to invest in it," Uekert said.

But the study's comparisons go beyond just cost factors to help point the way to potential solutions, she said.

"There are trade-offs to all recycling technologies," Uekert said. "We're never going to have one silver bullet that is going to solve that plastic pollution problem. There's a lot of exciting work out there. And I think if we are able to improve upon these technologies, and figure out how they can

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work in synergy, there's a lot of potential for making sure we're reaching a circular economy for plastics."

Inside Climate News, 19 January 2023

<https://insideclimatenews.org>

### Dirty Waterways May Alter Fish Behavior

2023-01-16

The world's aquatic habitats are a heady brew of pollutants. An estimated 14 million tons of plastic enter the ocean as trash each year. Further inland, more than 40 percent of the world's rivers contain a pharmacopeia from humans, including antidepressants and painkillers. Heavy metals like mercury from industrial waste can also make an appearance. And agricultural fertilizer can leach from the soil into rivers, eventually reaching the ocean.

There are an estimated 20,000 species of fish in the world — and possibly many more. They and many other organisms that live in "contaminated systems are contaminated with a cocktail of chemicals," said Michael Bertram, a behavioral ecologist at the Swedish University of Agricultural Studies.

Bertram and other researchers are increasingly finding that these compounds may alter fish behavior. In some experiments, the pollutants appear to alter how fish socialize, either by exposing them to psychoactive drugs or by altering their natural development, which may change how they swim together and mate. Others appear to make fish take more risks which, in the wild, could increase their odds of getting unceremoniously taken out by predators.

The effects of the pollution, according to researchers working in the field, still have many unknowns. This is due in part to the vast number of variables in real ecosystems, which can limit scientists' abilities to infer how pollutants impact fish in the wild, said Quentin Petitjean, a postdoctoral researcher in environmental sciences at Institut Sophia Agrobiotech in France, and co-author of a 2020 paper that looked at existing literature on pollution and fish behavior. "In the wild, fish and other organisms are exposed to a plethora of stressors," he said.

Still, these altered behaviors could have big impacts, according to Bertram. Like many living things, fish are important parts of their ecosystems, and changing their behavior could hinder or alter their roles in unexpected ways. For instance one study suggests that various chemical pollutants

**Plastics, drugs, and more may change how fish socialize or take risks, although the specifics are difficult to pinpoint.**



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and microplastics can impact the boldness of prey fish species. Although the authors note that this isn't likely to lead to population collapse, these "subtle behavior modifications" could reduce fish biomass, alter their size, and ultimately harm predators as well. Just this one effect, they add, "may be a hidden mechanism behind ecosystem structure changes in both freshwater and marine ecosystems."

But humans have a funny way of showing their appreciation. One example: People regularly flush psychoactive substances, which then find their way into aquatic ecosystems. In 2021, Bertram and a team of researchers published a paper digging into how a common antidepressant, fluoxetine, better known under the brand name Prozac, affected guppies' propensity for shoaling, or swimming in groups. Over two years, the team exposed groups of guppies to different concentrations of fluoxetine: a low concentration (commonly seen in the wild), a high concentration (representative of an extremely contaminated ecosystem), and no fluoxetine at all.

At the high exposure concentration, the guppies appeared to be more social, spending more time shoaling. However, this was only the case in of male-female pairs, not when the fish swam solo. Previous research by Bertram and colleagues shows that the medication increases the amount of time guppy males spend pursuing females. "Being intensely courted" by males, Bertram said, the females will preferentially choose the larger school to distract them and "to avoid this incessant mating behavior."

While drugs like Prozac are designed to change brain function, there are other, perhaps less obvious ways pollution can change behavior. For instance, pollutants may alter the microbiome, the collection of microscopic organisms like fungi and bacteria that exist on or in an organism. In humans, disruptions of microbial life have been linked to disorders such as autism spectrum disorder, dementia, or even simply cognitive impairment. Research published in 2022 suggests that fish brains may also rely on the collection of minuscule organisms.

In the study, researchers worked with two groups of zebrafish embryos that they had rendered germ-free, functionally stripping them of microbes. Into the containers holding one group of embryos, the team immediately introduced water from a tank with full-grown zebrafish to give the disinfected population a microbiome. After a week, they did the same for the other group.

After yet another week, the researchers ran a series of experiments, putting two fish from the same group in neighboring tanks to see if

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they would swim alongside each other, a shoaling behavior previously identified.

The fish deprived of an early life microbiome spent much less time doing this behavior than those in the control group. Of the 54 control fish, nearly 80 percent spent their time near the divider between the tanks, compared to around 65 percent of the 67 in the other group. Exposure to microbes early in life is important for the development of social behavior, said Judith Eisen, a neuroscientist and one of the paper's authors.

The researchers also looked at the brains of the fish using powerful microscopes. Normally, cells called microglia move from the gut to the brain early in the fishes' lives, Eisen said, around the time their microbiome starts to develop. The fish that lived without microbiomes for a week, she and the team found, had fewer microglia in a particular brain region which has been previously linked to the shoaling behavior. In normal brains (including human ones), these cells perform synaptic pruning, which clears away weaker or less used connections.

Of course, the germ-free state of those zebrafish, Eisen said, would not exist in nature. However, some human pollutants like pesticides, microplastics, and metals like cadmium appear to alter fish microbiomes. Considering shoaling is often a protective behavior, a diminished shoaling response may cause problems in the wild. "If it doesn't want to hang out with other fish — that might open it up to predation," Eisen said.

Pollutants can impact behavior beyond shoaling, and saltwater ecosystems as well. In a 2020 study, researchers took Ambon damselfish larvae back to the lab and exposed some of them to microplastic beads. Then, they returned the young fish to different stretches of the Great Barrier reef — some of which were degraded and others that were still healthy — and observed how they acted. The team had also tagged the fish with tiny fluorescent tags, and returned to the reef several times over three days to check on their survival rate.

The fish that had been exposed to microplastics showed more risk-taking behavior and survived for less time before being preyed upon, according to the study. Nearly all the tagged fish that were exposed to microplastics and set free near dead reefs died after around 50 hours. Meanwhile, around 70 percent of unexposed fish released near living reefs survived past the 72-hour mark. According to the paper, while the health of the reef was a factor in risk behavior, fish exposed to the plastics had a survival rate six times lower than those not exposed to the compounds.



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According to Alexandra Gulizia, one of the paper's authors and a Ph.D. student at James Cook University, there needs to be more work looking into the components of plastics and how they affect fish. For instance, bisphenol-A, more commonly known as BPA, is a common additive to make plastics more flexible. It also appears in natural habitats and research suggests it can decrease aggression in fish. Gulizia added: "I think that we're only just touching the surface of the chemical impacts that microplastics are having on fish and fish behavior."

How this all plays out in the wild is hard to assess. Eisen noted that other factors that could impact the microbiome include nutrients in the water, water temperature, diet, and salt concentration. Another, perhaps more direct complication: Contaminants can appear simultaneously, and in different amounts, Petitjean said. For instance, one 2016 paper shows that 13 percent of 426 pollutants in European rivers have been shown to be neuroactive.

Another complication is simply that not all organisms will act the same — even within the same species. According to Eisen, model organisms, such as zebrafish, are chosen to represent a wide range of species, just as mice are often used to study human health in medical research. But changes to pollutants and other factors could differ from species to species. Bertram noted that using model organisms saves researchers the trouble of studying every single species, but also that there should be more studies into different fish.

"I think that we're only just touching the surface of the chemical impacts that microplastics are having on fish and fish behavior," Gulizia said.

At face value, some behavior changes might not even look that bad. Increased mating behavior — like in the case of guppies exposed to fluoxetine — could seem like a boon for the species. However, one species thriving over another tends to throw natural habitats out of whack, Bertram said. His previous work suggests that Prozac similarly increases invasive eastern mosquitofish mating behavior. This could help it thrive and outcompete native species. Additionally, at some concentrations, cadmium can increase fish activity, potentially helping them find food. However, the more they eat, Petitjean said, the more exposed they could be to microplastics.

Given these circumstances, he added, experiments in the lab need to inject as much complexity as possible into their methods to better replicate real, wild systems. Some research does try this. Bertram's work showed the test guppies either a predatory or a similarly sized, non-

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predatory fish prior to their experiments, while Gulizia and her team performed parts of their experiment in the wild. Some studies also expose fish species to water taken from the environment — and the pollutants that come with it.

Despite the unknowns, Bertram said that changes to how fish go about socializing, mating, or finding food are unlikely to be good. "At the end of the day," he continued, "any change to the expression of natural behaviors will have negative, unintended consequences."

Undark, 16 January 2023

<https://undark.org>

### Why the Hubble telescope is still in the game — even as JWST wows

2023-01-20

Once the James Webb Space Telescope (JWST) began operations last year, the comparisons began. Astronomers and others online posted side-by-side images of the same celestial objects captured by JWST and the Hubble Space Telescope, pointing out how much crisper and more detailed those from JWST can be.

But don't count Hubble out yet. The telescope, from NASA and the European Space Agency, is still making big discoveries, after going strong for nearly 33 years.

"There's still tons of science to be done with Hubble," says Beth Biller, an astronomer at the University of Edinburgh, UK, who chairs a committee representing scientists who use Hubble.

"People are saying, 'Is Hubble going to be useless now?'" adds Tom Brown, head of the Hubble mission office at the Space Telescope Science Institute (STScI) in Baltimore, Maryland. "It's not, because it has unique capabilities."

Whereas JWST detects infrared wavelengths, making it ideal for observing distant galaxies, Hubble studies the Universe mostly in other wavelengths, including high-energy ultraviolet light emitted from marvels such as exploding stars. It also has sharp vision at visible wavelengths, allowing the telescope to take unprecedented images of stars, galaxies and cosmic phenomena closer to Earth. Because no other observatory can do those jobs as broadly and as well, Hubble is still in high demand, with researchers making many more requests for its time than the telescope has available.

**NASA's nearly 33-year-old observatory still has plenty of top science to do, and astronomers want to extend its lifetime.**



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Astronomers want to maximize what they can get out of Hubble while it's still useful. Engineers estimate that the US\$16-billion telescope will continue working through the end of this decade and perhaps well into the 2030s. But the race is on to acquire as much science as possible in its remaining years — and to exploit its operational overlap with JWST.

### The only game in town

Many astronomers are most excited about Hubble's ability to detect UV wavelengths, which can't be studied well from the ground — Earth's atmosphere filters out most of that light. NASA does not plan to have another powerful UV telescope in space until the 2040s. "In the meantime, Hubble's pretty much the only game for a huge chunk of astrophysics," Brown says.

That includes UV light radiating from young stars, which glow as they gobble up gas and dust. Two years ago, STScI astronomers began surveying around 200 such stars, the largest observing programme ever done using Hubble. The goal is to create a library of UV information from these stars that future astronomers can use to understand stellar evolution. The survey is 96% complete.

Hubble also shines when studying 'transient' phenomena, such as exploding stars, which appear without warning in the night sky and need to be studied before they fade. Several current and planned sky surveys will spot many of these phenomena, and Hubble is uniquely suited to observing them in detail in UV or visible wavelengths as soon as they are discovered. Mission operators have even introduced 'flexible Thursdays' into Hubble's schedule — one Thursday per month is devoted to scheduling last-minute observations.

Astronomers are also teaching Hubble new tricks. Operators recently worked out how to use one of its instruments, the Advanced Camera for Surveys, to combine information about the spectra and polarization of light from celestial objects, which yields new insights into their nature.

Much of the focus in the upcoming years will be to coordinate Hubble and JWST observations, to get a fuller picture of cosmic phenomena. That might mean, for instance, using Hubble to look at nearby galaxies that resemble those spotted by JWST in the distant Universe, to create a timeline of galactic evolution, or to jointly study the atmospheres of exoplanets that Hubble has a long legacy of exploring.

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"The power of having both of these observatories greatly increases our ability to understand all of these areas of astrophysics," says Jennifer Wiseman, an astrophysicist at NASA's Goddard Space Flight Center in Greenbelt, Maryland, and Hubble's senior project scientist. "Now is the time to be using these facilities to their fullest."

### Not dead yet

Precisely how long Hubble has left isn't known. "If I asked you when's your car going to break down, you're not going to have a clue, and that's somewhat the world we're in," says Jim Jeletic, Hubble's deputy programme manager at the Goddard centre.

Launched in 1990 by astronauts aboard the Space Shuttle Discovery, Hubble has needed upgrades over the years. Astronauts visited it five times between 1993 and 2009, first to fix a mirror flaw that left it with blurry vision and then to enhance its scientific instruments to keep it at the cutting edge of astronomy. "That's kept Hubble like a new observatory over and over again," Wiseman says. But NASA retired the space shuttle in 2011, and has no plans to service the telescope again.

The basic systems that keep the telescope operating — such as the solar panels and batteries that power it, and the gyroscopes that orient it in space — are functional but ageing. Sometimes, things break with no warning, such as when Hubble's payload computer was offline for a month in 2021. Engineers ultimately got it working again, but on a backup system. They are still trying to re-boot the initial system for Hubble to use if the backup fails.

Operators are also looking for smarter ways to run the telescope to extend its lifetime. For instance, engineers changed how Hubble communicates with satellites to relay data to Earth. Instead of using the telescope's on-board transponders in many short bursts, mission controllers now collect more data on the telescope before sending a chunk of data all at once. Switching the transponders on and off less frequently extends their lifetime.

### Getting a lift

Another long-term question is how long Hubble can stay high enough to escape the drag of Earth's atmosphere, which brings it lower in altitude and will ultimately destroy it. In the past, the telescope has orbited as high as 615 kilometres above our planet's surface; it is currently at 535 kilometres, where it is expected to remain until around the mid-2030s.



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But if the Sun reaches its predicted maximum activity in 2025, solar storms could accelerate Hubble's demise. So NASA and aerospace company SpaceX, based in Hawthorne, California, are studying whether they can attach a SpaceX capsule to Hubble and boost it to a higher orbit. That would give NASA more time to work out how to get rid of the telescope at the end of its lifetime, by guiding it down into the ocean. The results of the orbit-boosting study are not yet scheduled for public release.

"We believe we'll be able to keep Hubble making unique and great scientific discoveries and observations into the end of this decade, if not into the next," Jeletic says.

In the meantime, there is plenty to do. Although Hubble has taken more than 1.5 million observations in its lifetime, it has looked at less than one-tenth of one per cent of the sky.

"It's amazing to me, this number," Jeletic says. "There is a lot of stuff out there that we have not looked at."

Nature, 20 January 2023

<https://nature.com>

### Unlocking the Secrets of Aging: Researchers Discover Previously Unknown Mechanism That Drives Aging

2023-01-23

A groundbreaking study by researchers at Northwestern University has uncovered a previously unknown mechanism that controls aging.

Utilizing artificial intelligence, the team analyzed data from a wide range of tissues from humans, mice, rats, and killifish. They discovered that the length of genes plays a significant role in the molecular changes that occur during aging.

All cells must balance the activity of long and short genes. The researchers found that longer genes are linked to longer lifespans, and shorter genes are linked to shorter lifespans. They also found that aging genes change their activity according to length. More specifically, aging is accompanied by a shift in activity toward short genes. This causes the gene activity in cells to become unbalanced.

Surprisingly, this finding was near universal. The researchers uncovered this pattern across several animals, including humans, and across many

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tissues (blood, muscle, bone, and organs, including liver, heart, intestines, brain, and lungs) analyzed in the study.

The new finding potentially could lead to interventions designed to slow the pace of — or even reverse — aging. The study was recently published in the journal *Nature Aging*.

"The changes in the activity of genes are very, very small, and these small changes involve thousands of genes," said Northwestern's Thomas Stoeger, who led the study. "We found this change was consistent across different tissues and in different animals. We found it almost everywhere. I find it very elegant that a single, relatively concise principle seems to account for nearly all of the changes in the activity of genes that happen in animals as they age."

"The imbalance of genes causes aging because cells and organisms work to remain balanced — what physicians denote as homeostasis," said Northwestern's Luís A.N. Amaral, a senior author of the study. "Imagine a waiter carrying a big tray. That tray needs to have everything balanced. If the tray is not balanced, then the waiter needs to put in extra effort to fight the imbalance. If the balance in the activity of short and long genes shifts in an organism, the same thing happens. It's like aging is this subtle imbalance, away from equilibrium. Small changes in genes do not seem like a big deal, but these subtle changes are bearing down on you, requiring more effort."

An expert in complex systems, Amaral is the Erastus Otis Haven Professor of Chemical and Biological Engineering in Northwestern's McCormick School of Engineering. Stoeger is a postdoctoral scholar in Amaral's laboratory.

### Looking across ages

To conduct the study, the researchers used various large datasets, including the Genotype-Tissue Expression Project, a National Institutes of Health-funded tissue bank that archives samples from human donors for research purposes.

The research team first analyzed tissue samples from mice — aged 4 months, 9 months, 12 months, 18 months, and 24 months. They noticed the median length of genes shifted between the ages of 4 months and 9 months, a finding that hinted at a process with an early onset. Then, the team analyzed samples from rats, aged 6 months to 24 months, and killifish, aged 5 weeks to 39 weeks.



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“There already seems to be something happening early in life, but it becomes more pronounced with age,” Stoeger said. “It seems that, at a young age, our cells are able to counter perturbations that would lead to an imbalance in gene activity. Then, suddenly, our cells are no longer able to counter it.”

After completing this research, the researchers turned their attention to humans. They looked at changes in human genes from ages 30 to 49, 50 to 69 and then 70 and older. Measurable changes in gene activity according to gene length already occurred by the time humans reached middle age.

“The result for humans is very strong because we have more samples for humans than for other animals,” Amaral said. “It was also interesting because all the mice we studied are genetically identical, the same gender, and raised in the same laboratory conditions, but the humans are all different. They all died from different causes and at different ages. We analyzed samples from men and women separately and found the same pattern.”

**‘Systems-level’ changes**

In all animals, the researchers noticed subtle changes to thousands of different genes across samples. This means that not just a small subset of genes that contribute to aging. Aging, instead, is characterized by systems-level changes.

This view differs from prevailing biological approaches that study the effects of single genes. Since the onset of modern genetics in the early 20th century, many researchers expected to be able to attribute many complex biological phenomena to single genes. And while some diseases, such as hemophilia, do result from single gene mutations, the narrow approach to studying single genes has yet to lead to explanations for the myriad changes that occur in neurodegenerative diseases and aging.

“We have been primarily focusing on a small number of genes, thinking that a few genes would explain the disease,” Amaral said. “So, maybe we were not focused on the right thing before. Now that we have this new understanding, it’s like having a new instrument. It’s like Galileo with a telescope, looking at space. Looking at gene activity through this new lens will enable us to see biological phenomena differently.”

**Lengthy insights**

After compiling the large datasets, many of which were used in other studies by researchers at Northwestern University Feinberg School of

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Medicine and in studies outside Northwestern, Stoeger brainstormed an idea to examine genes, based on their length.

The length of a gene is based on the number of nucleotides within it. Each string of nucleotides translates to an amino acid, which then forms a protein. A very long gene, therefore, yields a large protein. And a short gene yields a small protein. According to Stoeger and Amaral, a cell needs to have a balanced number of small and large proteins to achieve homeostasis. Problems occur when that balance gets out of whack.

Although the researchers did find that long genes are associated with increased lifespans, short genes also play important roles in the body. For example, short genes are called upon to help fight off pathogens.

“Some short genes could have a short-term advantage on survival at the expense of ultimate lifespan,” Stoeger said. “Thus, outside of a research laboratory, these short genes might help survival under harsh conditions at the expense of shortening the animal’s ultimate lifespan.”

**Suspected ties to long COVID-19**

This finding also may help explain why bodies take longer to heal from illnesses as they age. Even with a simple injury like a paper cut, an older person’s skin takes a longer time to recover. Because of the imbalance, cells have fewer reserves to counteract the injury.

“Instead of just dealing with the cut, the body also has to deal with this activity imbalance,” Amaral hypothesized. “It could explain why, over time with aging, we don’t handle environmental challenges as well as when we were younger.”

And because thousands of genes change at the system level, it doesn’t matter where the illness starts. This could potentially explain illnesses like long COVID-19. Although a patient might recover from the initial virus, the body experiences damage elsewhere.

“We know cases where infections — predominantly viral infections — lead to other problems later in life,” Amaral said. “Some viral infections can lead to cancer. Damage moves away from the infected site and affects other areas of our body, which then is less able to fight environmental challenges.”

**Hope for medical interventions**

The researchers believe their findings could open new venues for the development of therapeutics, designed to reverse or slow aging. Current



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therapeutics to treat illness, the researchers argue, are merely targeting the symptoms of aging rather than aging itself. Amaral and Stoeger compare it to using Tylenol to reduce a fever instead of treating the illness that caused the fever.

"Fevers can occur for many, many reasons," Amaral said. "It could be caused by an infection, which requires antibiotics to cure, or caused by appendicitis, which requires surgery. Here, it's the same thing. The issue is the gene activity imbalance. If you can help correct the imbalance, then you can address the downstream consequences."

Other Northwestern co-senior authors include Richard Morimoto, a professor of molecular biosciences in the Weinberg College of Arts and Sciences; Dr. Alexander Misharin, an associate professor of medicine at Feinberg; and Dr. G.R. Scott Budinger, the Ernest S. Bazley Professor of Airway Diseases at Feinberg and chief of pulmonary and critical care at Northwestern Medicine.

Sci Tech Daily, 23 January 2023

<https://scitechdaily.com>

### Turning problem sea algae into a replacement for plastic

2023-01-23

Mari Granström says it was her passion for scuba diving that opened her eyes to the continuing problem of toxic algae blooms in the Baltic Sea.

The outbreaks occur when tiny cyanobacteria, also called blue-green algae, suddenly multiply rapidly, stretching out on top of the water for potentially kilometres.

Also called eutrophication, it is a form of marine suffocation, and it is a significant environmental concern in the Baltic Sea. It can occur in 97% of the total area of the sea, according to official figures.

The blooms impact on other marine life, by causing oxygen deficiency, reducing water quality, and blocking out light.

The problem is caused by too many nutrients entering the water, typically nitrogen and phosphorus from artificial fertilisers. These are carried into the sea by the rivers of the surrounding countries - Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden.

**Excessive outbreaks of seaweed are clogging up waters from the Caribbean to the Baltic. Now the algae is being harvested alongside farmed crops to create ingredients for cosmetics and food products.**

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While the use of such fertilisers has reduced in recent years, the Baltic Marine Environment Protection Commission, the intergovernmental organisation that aims to improve water quality in the sea, says "the effect of these measures has not yet been detected".

Some six years ago Ms Granström, a Finnish biochemist, determined to tackle the problem herself. She'd harvest the algae and use it to make ingredients for a host of products. In addition to cosmetics and human food, the algae extracts can be used in detergents, animal feed, packaging, and even as a replacement for plastic.

This comes as there is a growing trend for seaweed to be harvested for such purposes, as a replacement to oil-based ingredients.

"I saw with my own eyes - or perhaps couldn't see - how it was affecting the marine ecosystem, and decided to do something," she says. "There was too much finger pointing and not enough action."

Ms Granström says she worked on the project as "a hobby for a long time", before in 2019 setting up a company called Origin by Ocean (ObO). She is the chief executive.

The business, which has attracted both commercial investment and European Union funds, is now continuing with a pilot production scheme ahead of aiming to be fully operational by 2025-26.

ObO collects the algae off the coast of Finland, where it is sucked on to boats and then separated from the water. The firm is also importing invasive sargassum seaweed from the Dominican Republic in the Caribbean.

Vast blooms of that algae have plagued that region for a number of years. "There are 25 million tonnes of sargassum blooming in the Caribbean every year," says Ms Granström.

"It stops people fishing and harms tourism. We are now buying several tonnes of sargassum from the Dominican Republic, and this volume will increase."

The company further sources unwanted seaweed from Portuguese and Spanish waters.

ObO's pilot processing is done at a facility in northern Finland. It uses a patented biorefinery technology it calls "Nauvu" to separate the algae into numerous useable materials.



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These are then sold to food, cosmetics, textiles, packing and agricultural companies.

To help grow the business ObO is working with one of its investors, Finnish chemicals and industrial group Kiilto. "If this can be successfully scaled up here, then ObO can replicate similar processes around the globe," says Ville Solja, Kiilto's chief business development officer.

ObO already has plans to set up a refinery in the Dominican Republic.

Across in Sweden, a separate business called Nordic Seafarm is showing just how versatile seaweed can be.

"We make algae-based gin and beer, both locally produced," says director Fredrik Gröndahl.

Nordic Seafarm, which grows its own seaweed, is a commercial spin-off from Seafarm, a Swedish government-funded project that helps commercialise aquaculture research.

"If this market [for seaweed] gets big, and we think it will, we are ready to scale up," adds Prof Gröndahl, who is also project leader of Seafarm, and head of department for sustainable development, environmental science and engineering at the KTH Royal Institute of Technology in Stockholm.

"Just imagine if Ikea asked for algae-based meatballs globally, which could happen."

Prof Gröndahl also hopes that in the future algae will become a key ingredient in animal feed, to replace environmentally-damaging fish meal, which is common in pigs and poultry diets. "Algae is also cheaper than existing ingredients as there is no cost for feeding and irrigation."

Back at ObO, Ms Granström says the aim is for shoppers around the world to "play a part in cleaning up the Baltic Sea" by simply buying a number of consumer products.

"We wanted to do something to help at both ends of the process, upstream and downstream, as it were - cleaning the seas, but also monetising a change in consumer behaviour."

BBC News, 23 January 2023

<https://bbc.com>

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### Ultrasound 'tornado' breaks up brain blood clots

2023-01-23

The approach worked more quickly than existing techniques to eliminate clots formed in an in vitro model of cerebral venous sinus thrombosis (CVST), according to a new study.

"Our previous work looked at various techniques that use ultrasound to eliminate blood clots using what are essentially forward-facing waves," says Xiaoning Jiang, co-corresponding author of the paper in the journal Research. "Our new work uses vortex ultrasound, where the ultrasound waves have a helical wavefront.

"In other words, the ultrasound is swirling as it moves forward," says Jiang, professor of mechanical and aerospace engineering at North Carolina State University. "Based on our in vitro testing, this approach eliminates blood clots more quickly than existing techniques, largely because of the shear stress induced by the vortex wave."

"The fact that our new technique works quickly is important, because CVST clots increase pressure on blood vessels in the brain," says Chengzhi Shi, co-corresponding author and an assistant professor of mechanical engineering at Georgia Institute of Technology. "This increases the risk of a hemorrhage in the brain, which can be catastrophic for patients.

"Existing techniques rely in large part on interventions that dissolve the blood clot. But this is a time-consuming process. Our approach has the potential to address these clots more quickly, reducing risk for patients."

CVST occurs when a blood clot forms in the veins responsible for draining blood from the brain. Incidence rates of CVST were between 2 and 3 per 100,000 in the United States in 2018 and 2019, and the incidence rate appears to be increasing.

"Another reason our work here is important is that current treatments for CVST fail in 20-40% of cases," Jiang says.

The new tool consists of a single transducer that is specifically designed to produce the swirling, vortex effect. The transducer is small enough to be incorporated into a catheter, which is then fed through the circulatory system to the site of the blood clot.

For proof-of-concept in vitro testing, the researchers used cow blood in a 3D-printed model of the cerebral venous sinus.

**A new tool and technique uses "vortex ultrasound," a sort of ultrasonic tornado, to break down blood clots in the brain.**



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“Based on available data, pharmaceutical interventions to dissolve CVST blood clots take at least 15 hours, and average around 29 hours,” Shi says. “During in vitro testing, we were able to dissolve an acute blood clot in well under half an hour.”

During any catheterization or surgical intervention there is a potential risk of harm, such as damaging the blood vessel itself. To address this issue, the researchers performed experiments applying vortex ultrasound to animal blood vein samples. Those tests found no damage to the walls of the blood vessels.

The researchers also conducted tests to determine whether the vortex ultrasound caused significant damage to red blood cells. They found that there was not substantial damage to red blood cells.

“The next step is for us to perform tests using an animal model to better establish the viability of this technique for CVST treatment,” Jiang says. “If those tests are successful, we hope to pursue clinical trials.”

“And if the vortex ultrasound ever becomes a clinical application, it would likely be comparable in cost to other interventions used to treat CVST,” says Shi.

Bohua Zhang, a PhD student, Huaiyu Wu, a postdoctoral researcher, both at NC State, and Howuk Kim, a former PhD student at NC State now on faculty at Inha University, are co-lead authors of the paper. Additional coauthors are from Georgia Tech, the University of Michigan, the University of Pittsburgh Medical Center, UNC Chapel Hill, and NC State.

The National Institutes of Health and the National Science Foundation funded the work.

Futurity, 23 January 2023

<https://futura.org>

### Alarm Bells Ring for Great Hammerheads After Scientists Sequence the Genomes of Endangered Sharks

2023-01-23

“With their whole genomes deciphered at high resolution we have a much better window into the evolutionary history of these endangered species,” says Professor Mahmood Shivji.

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It’s a startling image that describes a milestone in conservation science for sharks. Professor Shivji, Professor Michael Stanhope and their collaborators have glanced back in history by sequencing to chromosome level the genomes (entire genetic blueprint) of great hammerhead and shortfin mako sharks. Their DNA timeline shows that their populations have declined substantially over 250,000 years. What the scientists have also found is worrying: great hammerhead sharks have low genetic variation, which makes them less resilient to adapting to our rapidly changing world. The species also shows signs of inbreeding, an issue that can lower the ability of its populations to survive. The shortfin mako shark, however, showed higher diversity and limited inbreeding, a hopeful glint in the gloomy conservation climate. Understanding change over such a large timescale can put into context the current conservation status of these endangered animals. The results can help direct us towards much more nuanced management strategies for sharks.

The findings are published in a paper in iScience: “Genomes of endangered great hammerhead and shortfin mako sharks reveal historic population declines and high levels of inbreeding in great hammerhead,” led by Professor Stanhope from Cornell University and Professor Shivji, director of the Save Our Seas Foundation Shark Research Center and Guy Harvey Research Institute, Nova Southeastern University, with collaborators from Cornell University, Nova Southeastern University, Temple University, Governors State University, and the San Diego Zoo Wildlife Alliance.

The scientists acquired and assembled entire genome sequences for great hammerhead and shortfin mako sharks and compared their genomes with genome information available for the whale shark, white shark, brownbanded bamboo shark, and cloudy catshark. Their methods read like complex puzzle-building by scientific sleuths: successively assembling from tiny fragments of DNA different sequences like a great patchwork tapestry that details the blueprint of life. Reaching chromosome level represents the latest in high-quality whole genome sequence research – and a tricky feat to achieve for species like sharks that have enormous genomes.

The application of advancing techniques comes amidst bleak reports for sharks and rays.

“Technical advances in the study of genomes mean that DNA sequencing approaches are much more powerful and efficient now”, says Professor Stanhope. “We can apply these new technologies to gain insights about

**Low genetic diversity and signs of inbreeding ring alarm bells for great hammerheads, but there may be hope for shortfin makos that showed higher genetic diversity and limited inbreeding.**



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the organism, information that we hope can be leveraged to protect sharks and rays.”

While we don't know exactly the effects of inbreeding in sharks, findings from wolves and cheetahs show that problematic traits can creep in over time. The result is often lowered survival of the species. The picture for great hammerhead sharks – overfished and traded for their fins – is worrying. But without these critical genetic insights, we would be unable to modify how their vulnerable populations are currently managed.

The researchers are cautious about overstating results.

“Genetics has advanced such that chromosomal level genomes are the expectation for a reference quality genome for species. However, conservation research presents its own challenges to achieving this consistently and at the resolution expected in other fields.” Professor Shivji adds that: “Obtaining tissue samples from endangered marine vertebrates is a major hurdle. You can assemble the genome with a single tissue sample from a single shark, but the ideal circumstance would be to sequence genomes from multiple individuals from different parts of their ocean range, an ethically difficult and costly endeavor.”

Indeed, the researchers state this as a limitation of their current study. The ethical limitations to working with endangered species means that conservation geneticists must balance the latest advances with respect for the fragile populations they study. In addition to revealing the genetic diversity and fragile status of two endangered shark species, the researchers hope that their results will provide what they term reference-quality genomes, from which future foundational science can build to improve what we know about sharks. Certainly, as new possibilities arise, our insights into the blueprint of sharks will help strengthen the way we understand these ecologically important species and conserve their vulnerable populations.

Sci Tech Daily, 23 January 2023

<https://scitechdaily.com>

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## Curiosities

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### How Intermittent Fasting Extends Life Spans – Time-Restricted Eating Reshapes Gene Expression Throughout the Body

2023-01-20

Numerous studies have shown health benefits of time-restricted eating including increase in life span in laboratory studies. This has made practices like intermittent fasting a hot topic in the wellness industry. However, exactly how it affects the body on the molecular level, and how those changes interact across multiple organ systems, has not been well understood. Now, Salk scientists show in mice how time-restricted eating influences gene expression across more than 22 regions of the body and brain. Gene expression is the process through which genes are activated and respond to their environment by creating proteins.

The findings, published in *Cell Metabolism* on January 3, 2023, have implications for a wide range of health conditions where time-restricted eating has shown potential benefits, including diabetes, heart disease, hypertension, and cancer.

“We found that there is a system-wide, molecular impact of time-restricted eating in mice,” says Professor Satchidananda Panda, senior author and holder of the Rita and Richard Atkinson Chair at Salk. “Our results open the door for looking more closely at how this nutritional intervention activates genes involved in specific diseases, such as cancer.”

For the study, two groups of mice were fed the same high-calorie diet. One group was given free access to the food. The other group was restricted to eating within a feeding window of nine hours each day. After seven weeks, tissue samples were collected from 22 organ groups and the brain at different times of the day or night and analyzed for genetic changes. Samples included tissues from the liver, stomach, lungs, heart, adrenal gland, hypothalamus, different parts of the kidney and intestine, and different areas of the brain.

The authors found that 70 percent of mouse genes respond to time-restricted eating.

“By changing the timing of food, we were able to change the gene expression not just in the gut or in the liver, but also in thousands of genes in the brain,” says Panda.

Nearly 40 percent of genes in the adrenal gland, hypothalamus, and pancreas were affected by time-restricted eating. These organs are

**“Circadian rhythms are everywhere in every cell.”**



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important for hormonal regulation. Hormones coordinate functions in different parts of the body and brain, and hormonal imbalance is implicated in many diseases from diabetes to stress disorders. The results offer guidance to how time-restricted eating may help manage these diseases.

Interestingly, not all sections of the digestive tract were affected equally. While genes involved in the upper two portions of the small intestine—the duodenum and jejunum—were activated by time-restricted eating, the ileum, at the lower end of the small intestine, was not. This finding could open a new line of research to study how jobs with shiftwork, which disrupts our 24-hour biological clock (called the circadian rhythm) impact digestive diseases and cancers. Previous research by Panda's team showed that time-restricted eating improved the health of firefighters, who are typically shift workers.

The researchers also found that time-restricted eating aligned the circadian rhythms of multiple organs of the body.

“Circadian rhythms are everywhere in every cell,” says Panda. “We found that time-restricted eating synchronized the circadian rhythms to have two major waves: one during fasting, and another just after eating. We suspect this allows the body to coordinate different processes.”

Next, Panda's team will take a closer look at the effects of time-restricted eating on specific conditions or systems implicated in the study, such as atherosclerosis, which is a hardening of the arteries that is often a precursor to heart disease and stroke, as well as chronic kidney disease.

Sci Tech Daily, 20 January 2023

<https://scitechdaily.com>

### A Solution to Excess CO<sub>2</sub>? New Study Proposes Fertilizing the Ocean

2023-01-20

Iron-based fertilizer in the form of nanoparticles has the potential to store excess carbon dioxide in the ocean.

An international team of researchers led by Michael Hochella of the Pacific Northwest National Laboratory suggests that utilizing tiny organisms could be a solution to addressing the pressing need to remove excess carbon dioxide from the Earth's environment.

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The team conducted an analysis, published in the journal *Nature Nanotechnology*, on the possibility of seeding the oceans with iron-rich engineered fertilizer particles near ocean plankton, crucial microscopic plants in the ocean ecosystem, to boost the growth and carbon dioxide uptake of phytoplankton.

“The idea is to augment existing processes,” said Hochella, a Laboratory fellow at Pacific Northwest National Laboratory. “Humans have fertilized the land to grow crops for centuries. We can learn to fertilize the oceans responsibly.”

In nature, nutrients from the land reach oceans through rivers and blowing dust to fertilize plankton. The research team proposes moving this natural process one step further to help remove excess CO<sub>2</sub> through the ocean. They studied evidence that suggests adding specific combinations of carefully engineered materials could effectively fertilize the oceans, encouraging phytoplankton to act as a carbon sink. The organisms would take up carbon in large quantities. Then, as they die, they would sink deep into the ocean, taking the excess carbon with them. Scientists say this proposed fertilization would simply speed up a natural process that already safely sequesters carbon in a form that could remove it from the atmosphere for thousands of years.

“At this point, time is of the essence,” said Hochella. “To combat rising temperatures, we must decrease CO<sub>2</sub> levels on a global scale. Examining all our options, including using the oceans as a CO<sub>2</sub> sink, gives us the best chance of cooling the planet.”

### Pulling insights from the literature

In their analysis, the researchers argue that engineered nanoparticles offer several attractive attributes. They could be highly controlled and specifically tuned for different ocean environments. Surface coatings could help the particles attach to plankton. Some particles also have light-absorbing properties, allowing plankton to consume and use more CO<sub>2</sub>. The general approach could also be tuned to meet the needs of specific ocean environments. For example, one region might benefit most from iron-based particles, while silicon-based particles may be most effective elsewhere, they say.

The researchers' analysis of 123 published studies showed that numerous non-toxic metal-oxygen materials could safely enhance plankton growth. The stability, Earth abundance, and ease of creation of these materials make them viable options as plankton fertilizers, they argue.

### Seeding the oceans with nano-scale fertilizers could create a much-needed, substantial carbon sink.



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The team also analyzed the cost of creating and distributing different particles. While the process would be substantially more expensive than adding non-engineered materials, it would also be significantly more effective.

Sci Tech Daily, 20 January 2023

<https://scietchdaily.com>

### **Evolving “Backward” – Discovery Overturns More Than a Century of Knowledge About the Origin of Modern Birds**

2023-01-20

Fossilized remains of a skeleton found within a small rock have challenged a long-held belief about the evolution of modern birds.

A team of researchers from the University of Cambridge and the Natuurhistorisch Museum Maastricht discovered that a crucial skull feature of modern birds, the mobile beak, had developed prior to the mass extinction event that wiped out the dinosaurs 66 million years ago.

This finding also suggests that the skulls of ostriches, emus and their relatives evolved ‘backward’, reverting to a more primitive condition after modern birds arose.

Using CT scanning techniques, the Cambridge team identified bones from the palate, or the roof of the mouth, of a new species of large ancient bird, which they named *Janavis finalidens*. It lived at the very end of the Age of Dinosaurs and was one of the last-toothed birds to ever live. The arrangement of its palate bones shows that this ‘dino-bird’ had a mobile, dexterous beak, almost indistinguishable from that of most modern birds.

For more than a century, it had been assumed that the mechanism enabling a mobile beak evolved after the extinction of the dinosaurs. However, the new discovery, reported in the journal *Nature*, suggests that our understanding of how the modern bird skull came to be needs to be re-evaluated.

Each of the roughly 11,000 species of birds on Earth today is classified into one of two over-arching groups, based on the arrangement of their palate bones. Ostriches, emus, and their relatives are classified into the palaeognath, or ‘ancient jaw’ group, meaning that, like humans, their palate bones are fused together into a solid mass.

**For more than a century, it had been assumed that the mechanism enabling a mobile beak evolved after the extinction of the dinosaurs.**

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All other groups of birds are classified into the neognath, or ‘modern jaw’ group, meaning that their palate bones are connected by a mobile joint. This makes their beaks much more dexterous, and helpful for nest-building, grooming, food-gathering, and defense.

The two groups were originally classified by Thomas Huxley, the British biologist known as ‘Darwin’s Bulldog’ for his vocal support of Charles Darwin’s theory of evolution. In 1867, he divided all living birds into either the ‘ancient’ or ‘modern’ jaw groups. Huxley’s assumption was that the ‘ancient’ jaw configuration was the original condition for modern birds, with the ‘modern’ jaw arising later.

“This assumption has been taken as a given ever since,” said Dr. Daniel Field from Cambridge’s Department of Earth Sciences, the paper’s senior author. “The main reason this assumption has lasted is that we haven’t had any well-preserved fossil bird palates from the period when modern birds originated.”

The fossil, *Janavis*, was found in a limestone quarry near the Belgian-Dutch border in the 1990s and was first studied in 2002. It dates from 66.7 million years ago, during the last days of the dinosaurs. Since the fossil is encased in rock, scientists at the time could only base their descriptions on what they could see from the outside. They described the bits of bone sticking out from the rock as fragments of skull and shoulder bones and put the unremarkable-looking fossil back in storage.

Nearly 20 years later, the fossil was loaned to Field’s group in Cambridge, and Dr. Juan Benito, then a Ph.D. student, started giving it another look.

“Since this fossil was first described, we’ve started using CT scanning on fossils, which enables us to see through the rock and view the entire fossil,” said Benito, now a postdoctoral researcher at Cambridge, and the paper’s lead author. “We had high hopes for this fossil – it was originally said to have skull material, which isn’t often preserved, but we couldn’t see anything that looked like it came from a skull in our CT scans, so we gave up and put the fossil aside.”

During the early days of the Covid-19 lockdown, Benito took the fossil out again. “The earlier descriptions of the fossil just didn’t make sense – there was a bone I was really puzzled by. I couldn’t see how what was first described as a shoulder bone could actually be a shoulder bone,” he said.

“It was my first in-person interaction in months: Juan and I had a socially distanced outdoor meeting, and he passed the mystery fossil bone to me,”



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said Field, who is also the Curator of Ornithology at Cambridge's Museum of Zoology. "I could see it wasn't a shoulder bone, but there was something familiar about it."

"Then we realized we'd seen a similar bone before, in a turkey skull," said Benito. "And because of the research we do at Cambridge, we happen to have things like turkey skulls in our lab, so we brought one out and the two bones were almost identical."

The realization that the bone was a skull bone, and not a shoulder bone, led the researchers to conclude that the unfused 'modern jaw' condition, which turkeys share, evolved before the 'ancient jaw' condition of ostriches and their relatives. For an unknown reason, the fused palates of ostriches and kin must have evolved at some point after modern birds were already established.

Two of the key characteristics we use to differentiate modern birds from their dinosaur ancestors are a toothless beak and a mobile upper jaw. While *Janavis finalidens* still had teeth, making it a pre-modern bird, its jaw structure is that of the modern, mobile kind.

"Using geometric analyses, we were able to show that the shape of the fossil palate bone was extremely similar to those of living chickens and ducks," said Pei-Chen Kuo, a co-author of the study. Added co-author Klara Widrig: "Surprisingly, the bird palate bones that are the least similar to that of *Janavis* are from ostriches and their kin." Both Kuo and Widrig are Ph.D. students in Field's lab at Cambridge.

"Evolution doesn't happen in a straight line," said Field. "This fossil shows that the mobile beak – a condition we had always thought post-dated the origin of modern birds, actually evolved before modern birds existed. We've been completely backward in our assumptions of how the modern bird skull evolved for well over a century."

The researchers say that while this discovery does not mean that the entire bird family tree needs to be redrawn, it does rewrite our understanding of a key evolutionary feature of modern birds.

And what happened to *Janavis*? It, like the large dinosaurs and other toothed birds, did not survive the mass extinction event at the end of the Cretaceous period. The researchers say that this may be because of its large size: *Janavis* weighed around 1.5 kilograms and was the size of a modern vulture. It's likely that smaller animals – like the 'wonderchicken', identified by Field, Benito, and colleagues in 2020, which comes from the

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same area and lived alongside *Janavis* – had an advantage at this point in Earth's history since they had to eat less to survive. This would have been beneficial after the asteroid struck the Earth and disrupted global food chains.

Sci Tech Daily, 20 January 2023

<https://website>

### The race to make diesel engines run on hydrogen

2023-01-21

It's a new hydrogen-diesel hybrid engine affectionately known as "baby number two" that could help to decarbonise some of Australia's heaviest industries.

The test rig is large - it has its own room adjoining a lab and looks at first glance like many other large motors, but beneath its metallic skin could lie game-changing technology.

Engineers at the University of New South Wales (UNSW) say they have successfully modified a conventional diesel engine to use a mix of hydrogen and a small amount of diesel, claiming their patented technology has cut carbon dioxide (CO<sub>2</sub>) emissions by more than 85%.

It's the work of Prof Shawn Kook and his team at the university's School of Mechanical and Manufacturing Engineering.

"The interest in converting an existing diesel engine into a clean-burning hydrogen engine is extremely high," Prof Kook tells the BBC at his laboratory in Sydney. Enquiries have come from Germany, South Africa, Brazil, Japan and China.

"We mount the hydrogen direct injection system into existing diesel engines, which can be applied to any conventional engine," he adds.

What makes their system unique, according to Prof Kook, is the way it mixes the hydrogen and diesel and then introduces it to the engine cylinder for combustion.

Unlike fossil fuels, hydrogen does not produce CO<sub>2</sub> when burnt, so it has long been seen as a greener fuel source.

About 90% of fuel in the UNSW hybrid diesel engine is hydrogen but it must be applied in a carefully calibrated way.

**"The idea of blending hydrogen and diesel together in an existing engine is something of a Holy Grail for decarbonising heavy industry and mining."**



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If the hydrogen is not introduced into the fuel mix at the right moment “it will create something that is explosive that will burn out the whole system,” Prof Kook explains.

He says that studies have shown that controlling the mixture of hydrogen and air inside the cylinder of the engine can help negate harmful nitrogen oxide emissions, which have been an obstacle to the commercialisation of hydrogen motors.

The Sydney research team believes that any diesel trucks and power equipment in the mining, transportation and agriculture sectors could be retrofitted with the new hybrid system in just a couple of months.

Prof Kook doubts the hybrid would be of much interest in the car industry though, where electric and hybrid vehicles are already advanced and replacing diesel cars.

However, he says Australia’s multibillion-dollar mining industry needs a solution for all its diesel-powered equipment as soon as possible.

“We have so many established diesel-powered generators, mega-trucks and underground machines. How do we decarbonise all those existing diesel engines? One way is to shut down everything and get new technology in, which will take decades,” he says.

The plan is for the hybrid to run off a hydrogen-diesel mix or, in the absence of hydrogen, it can revert to diesel only.

Prof Kook hopes his new generation engine will become a commercial product within two years.

Tim Buckley, the director at Climate Energy Finance, a public interest think-tank in Sydney, believes the technology has the potential to “transform the Australian mining industry dramatically”.

“There’s always an element of scepticism in the work I do to evaluate what is hype and hope as opposed to reality. Having said that, this University of New South Wales breakthrough does appear to be pretty material. If they can pull it off it is a huge opportunity,” he says.

The Australian team is in a global race to develop hybrid diesel-hydrogen engines. Engineers in other countries are working on their concepts and designs but the Sydney team believes it has an edge.

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“I think we have a breakthrough compared to most other research groups in the world where we can actually achieve a higher percentage using hydrogen over diesel,” explains Xinyu Liu, a UNSW PhD student from China.

“Emission-wise, CO<sub>2</sub>-wise we can achieve a higher reduction than the other methods. The concept has been proven using the previous small-scale engine. We are trying to implement this idea into a larger scale, which is more [applicable] to industry.”

The bigger version, or the UNSW’s “baby number two”, has twice the volume of the original prototype and has the potential for a “massive reduction in CO<sub>2</sub>” emissions, according to Prof Kook.

The vision is laid out in a paper published in the International Journal of Hydrogen Energy.

Much of the invention’s impact on the environment will depend on where the hydrogen comes from.

While small amounts of hydrogen are being extracted directly from the ground, most hydrogen is manufactured, in a process that emits CO<sub>2</sub>.

Green hydrogen, produced by using electricity from renewable power to split water into hydrogen and oxygen molecules using an electrolyser, is seen as the answer. But the technology and the electricity needed is costly, so at the moment only a small amount of hydrogen is produced this way.

But the costs are likely to come down and with abundant sunshine and wind, Australia has a lot of potential to produce renewable electricity, which could one day be used to make more green hydrogen.

The Climate Council, an independent organisation, believes that sustainable hydrogen gives Australia the chance to end its reliance on fossil fuels.

“Australia is one of the world’s largest coal exporters and the largest liquefied gas exporter,” the Council wrote in a 2021 briefing. “Both are polluting fossil fuels, and Australia is paying a high cost for that with more severe and frequent extreme weather events like bushfires, heatwaves, and drought.”

For now, the UNSW project remains in the nursery in the laboratory. Academic endeavour needs the financial heft of outside investment and the hands-on input and knowledge of a mining company or engine manufacturer.



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“Our vision is to impact Australian mining, agriculture and construction industries first and then move out to the rest of the world to make a bigger impact,” says Prof Kook.

Australia has some of the world’s biggest resources companies and they have all committed to aggressive decarbonisation targets. Technology is the key.

“The idea of blending hydrogen and diesel together in an existing engine is something of a Holy Grail for decarbonising heavy industry and mining,” adds Tim Buckley.

He has this existential question for the engineers at UNSW: “Can they actually deploy it in a commercial setting and replicate it outside the university?”

BBC News, 21 January 2023

<https://bbc.com>

### People exposed to weedkiller chemical have cancer biomarkers in urine – study

2023-01-20

New research by top US government scientists has found that people exposed to the widely used weedkilling chemical glyphosate have biomarkers in their urine linked to the development of cancer and other diseases.

The study, published last week in the Journal of the National Cancer Institute, measured glyphosate levels in the urine of farmers and other study participants and determined that high levels of the pesticide were associated with signs of a reaction in the body called oxidative stress, a condition that causes damage to DNA.

Oxidative stress is considered by health experts as a key characteristic of carcinogens.

The authors of the paper – 10 scientists with the National Institutes of Health and two from the Centers for Disease Control and Prevention (CDC) – concluded that their study “contributes to the weight of evidence supporting an association between glyphosate exposure and oxidative stress in humans”.

### Study measured glyphosate in urine and found high levels associated with signs of oxidative stress.

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They also noted that “accumulating evidence supports the role of oxidative stress in the pathogenesis of hematologic cancers”, such as lymphoma, myeloma and leukemia.

“Oxidative stress is not something you want to have,” said Linda Birnbaum, a toxicologist and former director of the National Institute for Environmental Health Sciences. “This study increases our understanding that glyphosate has the potential to cause cancer.”

The study findings come after the CDC reported last year that more than 80% of urine samples drawn from children and adults contained glyphosate. The CDC reported that out of 2,310 urine samples taken from a group of Americans intended to be representative of the US population, 1,885 contained detectable traces of glyphosate.

Glyphosate is the most heavily applied herbicide in history, both in the US and globally. One of the best-known glyphosate-based products is Monsanto’s Roundup weedkiller. Roundup has been used by farmers as well as consumers for more than 40 years. Officials with Monsanto and its German owner, Bayer AG, have always assured the public and regulators that exposure to the weedkiller does not pose a threat to human health.

Bayer said the new NIH study has many “significant methodological limitations that affect its reliability”, and said the results conflict with other government research.

“The increased oxidative stress found in the study could have been caused by any number of non-glyphosate-related factors or a combination of them, and the study does not support the conclusion that glyphosate is the cause,” Bayer said in a statement.

People are exposed to glyphosate by using products made with the chemical and also by eating food and drinking water contaminated with the pesticide. Scientists have found glyphosate residues in an array of popular foods and in waterways across the US.

Notably, in the new paper, the NIH and CDC scientists said that while their study focused on farmers who were exposed to glyphosate when they sprayed it on fields, they saw similar results in “non-farmers”.

The findings suggest “these effects may apply more broadly to the general population who are primarily exposed through ingestion of contaminated food and water or residential applications”, the study authors wrote.



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The study is so significant that it warrants regulatory attention, said some independent scientists.

“This is a top-level team of investigators and a highly credible study to which regulators need to pay attention,” said Phil Landrigan, a pediatrician and epidemiologist who worked for years at the CDC and the Environmental Protection Agency (EPA) and now directs the Program for Global Public Health and the Common Good at Boston College.

Michael Antoniou, a scientist with the department of medical and molecular genetics at King’s College in London who has been researching glyphosate for years, said the results were “worrying” with “major health implications”.

### Critical timing

The new government-funded study comes at a time when both the EPA and European regulators are completing updated assessments of glyphosate safety, and as health advocates are pushing for limits on use of the chemical or requirements that products such as Roundup be labelled with a cancer warning.

A European Food Safety Authority (EFSA) spokesperson told the Guardian the agency was aware of the study and would consider whether or not the findings add “new evidence” as the agency completes its new glyphosate assessment. EFSA’s conclusions are due in July. Glyphosate is still allowed in the EU but is under review.

The EPA also said it was looking over the new study and would “carefully review” the findings as it finalizes its assessment.

The study also comes as Monsanto and Bayer remain mired in litigation brought by tens of thousands of cancer patients who claim exposure to Roundup caused them to develop non-Hodgkin lymphoma. The company has already agreed to pay out more than \$11bn to settle the bulk of the claims – without admitting any liability – but many cases have not settled and civil trials are continuing.

Bayer is also facing a surge in investor unrest and calls for a breakup and the ouster of top leaders after the company lost 40% of its market value following its 2018 acquisition of Monsanto.

Bayer maintains that glyphosate does not cause cancer and that products made with it can be used safely. The company states on its website that

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EPA and other regulatory reviews of an “extensive body of research” back the company’s safety pledge.

Though some countries have moved to ban glyphosate products, regulatory agencies in many countries say there is a lack of evidence connecting glyphosate herbicides to cancer, and that it is one of the safest and most effective herbicides available.

Last year, a risk assessment committee of the European Chemicals Agency (ECHA) concluded after reviewing multiple studies that there was no justification for classifying glyphosate as a carcinogen.

Many large US farm groups, including the American Farm Bureau Federation, American Soybean Association, National Corn Growers Association, National Association of Wheat Growers, National Cotton Council, and American Sugarbeet Growers Association, also say that glyphosate is safe and doesn’t cause cancer.

The EPA has said for years that it considers glyphosate as “not likely” to be carcinogenic, and in a 2020 updated review, the agency reiterated it saw no “human health risks “of concern”. But the agency was forced to withdraw that safety determination last year after a federal appellate court invalidated the EPA’s assessment.

The court ruling said that the EPA did not properly follow scientific guidelines when it determined glyphosate was not carcinogenic, ignoring expert advice from scientific advisers, and using “inconsistent reasoning”.

The EPA now is revisiting its glyphosate evaluation but has said publicly it does not plan to change its position on the chemical’s safety for humans.

### Pregnancy worries

Debate over the safety of glyphosate has persisted for years and intensified after the International Agency for Research on Cancer (IARC), a unit of the World Health Organization, declared it “probably carcinogenic to humans” in 2015.

The new findings are not the first to look at glyphosate and oxidative stress. Animal studies and cellular studies have also found an association. But there are only a handful of such studies in humans.

The NIH study is the “largest investigation to date of the relationship between glyphosate exposure and oxidative stress markers”, said Jonathan Hofmann, an author of the study who is a scientist at the NIH’s National Cancer Institute.



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Scientists say it is important to examine substances that may cause oxidative stress because a large body of scientific evidence suggests that long-term oxidative stress contributes to the development not only of cancer but also a range of chronic conditions, such as diabetes, heart disease and reproductive problems, including male infertility.

One prior human study related to glyphosate and oxidative stress was published last year by a team of scientists specializing in public and environmental health at several US universities.

Those researchers analyzed 347 urine samples collected from pregnant women, finding that higher levels of oxidative stress biomarkers were seen in the samples containing concentrations of aminomethyl phosphonic acid (AMPA), a substance created when glyphosate breaks down in soil and water.

The authors of that paper noted that glyphosate and AMPA have been shown to disrupt hormone function and warned that more research was needed due to glyphosate's "persistence within the environment, and potential for adverse effects during pregnancy".

### Farmer health

The new NIH study is considered part of the Agricultural Health Study (AHS), a long-term examination of the health impacts of pesticide use on farmers funded by the National Cancer Institute and the National Institute of Environmental Health Sciences in collaboration with the EPA.

Other AHS studies have provided sometimes conflicting findings on the question of whether or not glyphosate can cause cancer, but the scientists authoring the latest research said their study was distinctive for several reasons, including using urinary glyphosate exposure measurements and pesticide exposure histories for study subjects and including people who are not farmers.

The researchers said that though the associations between glyphosate and biomarkers of oxidative stress "mainly appear to reflect effects of recent occupational exposure, there was also some evidence of associations with longer-term exposure".

Investigators at the NIH are exploring potential opportunities to follow up on these findings and address needs for future research as described above, Hofmann said.

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Lorette Picciano, executive director of the Rural Coalition alliance of farm workers, said she hopes the EPA will pay attention to the study.

"People are dying of these cancers," she said. "This study is very important."

The Guardian, 20 January 2023

<https://theguardian.com>

### 5 myths about gas stoves, the latest culture war clash

2023-01-20

The debate over the future of the gas stove has been going on for years, long before last week, when it turned into a full-fledged culture war.

Public health officials, researchers, and doctors have long been taking note of the abundant research linking pollution from the gas stove to respiratory problems, and the Consumer Product Safety Commission announced in December it was taking a look at the health risks to determine what regulations would be appropriate for the gas stove.

But after a member of the CPSC told Bloomberg in an interview last week that "products that can't be made safe can be banned," the fervor built quickly. Republicans (and some Democrats) portrayed the commissioner's remark as a sign that the Biden administration was coming for the gas stove as its next attack on American freedom. And plenty of defenders of the gas stove came out insisting it's the superior way to cook.

The fracas generated some new myths about gas stove regulation — and perpetuated other long-held misunderstandings. Here's how to separate fact from fiction.

#### Myth 1: Biden — or federal regulators — want to take your gas stove away

The hysteria that ensued when the Consumer Product Safety Commission said it would be taking a closer look at gas stoves could be summed up by a tweet from Rep. Ronny Jackson (R-TX). "I'll NEVER give up my gas stove. If the maniacs in the White House come for my stove, they can pry it from my cold dead hands. COME AND TAKE IT!!"

Some confusion comes from remarks from CPSC Commissioner Richard Trumka Jr., who told Bloomberg that "any option" is on the table as the independent agency considers the hazards posed by the gas stove: "Products that can't be made safe can be banned," he said. The CPSC later clarified those remarks: The commission said that there is no ban under

**One of the problem pollutants that come from a stove burning natural gas is nitrogen dioxide, which causes respiratory issues.**



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consideration, and “the CPSC is looking for ways to reduce related indoor air quality hazards.”

There are a lot of other options, like requiring range hood ventilation to be sold alongside the gas stove and warning labels, that the commission could consider before an outright ban. And any CPSC regulation for stoves would apply to new products being sold, not those already in people’s homes.

What’s more, it’s not the White House that’s calling all the shots here. The CPSC commissioners are appointed by the president, but otherwise, its regulations are not vetted through the White House, unlike the Environmental Protection Agency’s process. States and cities are also already taking action to minimize the climate and health risks involved with combusting gas indoors.

The White House has said it doesn’t support a ban, but it is promoting incentives through the Inflation Reduction Act that help people voluntarily electrify their homes.

### **Myth 2: Gas stove hazards are “newfound”**

In a letter to the CPSC’s Trumka, Sen. J.D. Vance (R-OH) calls the gas stove a “newfound ‘hidden hazard’ that rests on limited research.” In another section, Vance says there’s a “lack of compelling evidence.”

The study that caught national attention estimated that almost 13 percent of childhood asthma cases in the US are linked to gas stove use, similar to the level caused by secondhand smoke. That study is based on a review of the evidence from 2013, which examined 41 studies from multiple countries, dating as far back as 1977, to conclude that children living in households with gas stoves had a 42 percent higher risk of currently being diagnosed with asthma and a 24 percent higher risk of being diagnosed with asthma at some point in their life.

“Although the effects of gas cooking and indoor NO<sub>2</sub> on asthma and wheeze were found to be relatively small ... the public health impact may still be considerable because gas cooking is widespread,” the authors of the 2013 evidence review concluded.

These studies looked at the impact of gas cooking specifically. But there’s an even longer trail of studies looking at the pollutant nitrogen dioxide, which is emitted by gas stoves, and the damage it does to people exposed to it outdoors. In fact, outdoor NO<sub>2</sub> pollution is regulated by the EPA, which has done its own thorough reviews of NO<sub>2</sub> risks.

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### **Myth 3: No type of cooking can compare to the gas stove**

The idea that gas is vastly superior to all its alternatives is pervasive and is eagerly pushed by both appliance makers and the natural gas industry. Whirlpool, which manufactures both gas and electric, says matter-of-factly on its website, “If you like to make meals that require rapid temperature changes, gas ranges might be the way to go.”

The comparisons between gas and electric are usually comparing apples and oranges: the contemporary gas stove against dated electric stoves. The better modern equivalent is induction, which uses electromagnetic energy that makes the pans themselves a heat source, leaving the actual stovetop relatively cool. These new models come with settings that allow you to cook precisely at a certain temperature and hold that heat, with a lower risk of burns. Other positive reviews note that induction stoves are easier to clean and can boil water faster than gas stoves.

Chefs are also more split on induction versus gas than the public realizes. In a Vox interview, Jon Kung, a Detroit-based chef, noted that he prefers induction because it improves his indoor air quality and heat in the home. He also noted you can use woks with it, a common complaint about switching away from gas. Sierra magazine has talked to other chefs who prefer induction. “For me, it was an economic no-brainer,” chef Michael Godlewski said on opening an all-induction restaurant in Pittsburgh in spring 2022 called EYV (Eat Your Veggies). “They asked me where I wanted the gas line, and I said, ‘Nowhere.’”

An induction range is expensive; it can run you in the thousands of dollars. But the cost is coming down. One program some households may qualify for is the Inflation Reduction Act’s kitchen appliance tax credits and rebates. The 25C tax credits cover a range of energy-efficient products in the home, including an induction range. It allows you to deduct 30 percent of the costs of electrical work on the house (up to \$1,200). Later this year, there will be rebates available, too, under the High-Efficiency Electric Home Rebate Program. Households making up to 150 percent of the local median income will lower the upfront costs of the appliance and installation. Lower-income households (below 80 percent of the median income) can have all their costs covered under the program.

In the meantime, households that don’t want to wait or don’t qualify could also opt for a portable plug-in induction stovetop, which costs much less and is renter-friendly.

### **Myth 4: Most of America uses gas stoves**



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Gas stoves are common but not ubiquitous. Per the Energy Information Administration, on average, 38 percent of the country uses gas for cooking, or about 40 million stoves. But those numbers vary widely depending on where you are. New York, New Jersey, Illinois, and California have the highest rates of gas stoves in the country, over 60 percent. Southeastern states have some of the lowest rates in the country, under 20 percent.

Sen. Joe Manchin (D-WV) reacted to the CPSC uproar by tweeting, “I can tell you the last thing that would ever leave my house is the gas stove that we cook on.”

Manchin himself may have a gas stove, but many in his state do not. In fact, a survey from the EIA in 2020 found that a quarter of West Virginia residents have a gas cooking appliance, while 73 percent use electric.

The consequences of gas appliances aren’t also evenly distributed. Children, who have smaller lungs, are at higher risk of developing complications from NO<sub>2</sub>, and so are older adults and people with preexisting health conditions. Another risk factor is if a person is already exposed to other pollution sources in addition to the stove. They might live near a highway, an industrial site, or even in an area with concentrated gas appliances all venting outside, so they are breathing dirty air both outside and indoors.

#### Myth 5: As long as you use ventilation, the risks don’t matter

The American Gas Association’s website emphasizes that with ventilation like a working range hood, the gas stove is not a problem for indoor air quality. The Wall Street Journal editorial board echoed this: “Studies flogged by the climate left don’t account for the effects of ventilation. One even sealed a test kitchen in plastic tarps in an effort to show that gas stoves increase pollution.”

Ventilating the kitchen is the only solution we have to lessening exposure to pollutants when the stove or oven is on. But in practice, some hoods don’t vent the air outdoors but rather recirculate it inside, or people may be in a small space where pollution builds more quickly. Some issues are behavioral — like people not even using the hood they have, by neglecting to turn it on. Some of the problem is that not all hoods are capable of filtering out NO<sub>2</sub> levels. As journalist Michael Thomas explained, range hoods don’t always perform well in the real world. Studies, like at Lawrence Berkeley National Laboratory (LBNL) found that

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code-compliant hoods in California still captured just about half of NO<sub>2</sub> pollution.

More recent research from Stanford found that a gas stove can also be leaking methane, a greenhouse gas, even when the appliance is shut off. Inside the home, the level of methane is probably low enough that the researchers don’t consider these leaks to be a health threat. But methane is also a larger problem, not just for its climate risks but because it contributes to ground-level ozone that harms human health.

Vox, 20 January 2023

<https://vox.com>

#### Earth’s core may have paused and might even be reversing, says new study

2023-01-24

New research from a team in Beijing has suggested that Earth’s inner core might be doing the planet equivalent of ‘a 180’. According to decades worth of seismic activity, the inner core might have recently paused, and even be slowly reversing.

“Here, we show surprising observations that indicate the inner core has nearly ceased its rotation in the recent decade and may be experiencing a turning-back in a multidecadal oscillation, with another turning point in the early 1970s,” the team write in their new paper.

Earth’s inner core is a bit of a wild card. Because the solid inner core is sitting in a larger outer liquid core, it isn’t completely beholden to what the outer planet (like the mantle) is up to.

Understanding how both the inner and outer core works is important, as both seem to relate to the generation of Earth’s magnetic field. The spin of the inner core is driven by the magnetic field generated in the outer core and balanced by the gravitational effects of the mantle.

Knowing how the inner core rotates could illuminate how these layers interact. However, scientists have not yet been able to agree on the speed of this rotation, and whether it varies.

Scientists first thought that the inner core might be faster than the planet’s surface. Then it was slower, while a study we covered last year suggested it could even be oscillating over a six year cycle.

**The inner core is a complicated hunk of metal.**



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Now, the new research is suggesting that it could be oscillating not in six year long cycles, but seven DECADE long cycles.

Yi Yang and Xiaodong Song analysed the difference in the waveform and travel time of seismic waves from near-identical earthquakes that have passed through the Earth's inner core along similar paths since the 1960s.

They found that since around 2009, paths that previously showed significant temporal variation have exhibited little change, which they suggest shows that the inner core rotation has paused.

The team looked further back in time to the late 60s and early 70s and suggested that this may be associated with a reversal of the inner core rotation as part of a seven-decade oscillation, as the previous turning point occurring in the early 1970s.

If this was the case, it would line up with some geophysical observations too – particularly the way the magnetic field changes over time, and variations to the length of an Earth day.

“These observations provide evidence for dynamic interactions between the Earth's layers, from the deepest interior to the surface, potentially due to gravitational coupling and the exchange of angular momentum from the core and mantle to the surface,” the researchers write in their paper.

With such a shaky topic, this is unlikely to be the last we hear on the matter. The research has been published in Nature Geoscience.

Cosmos, 24 January 2023

<https://cosmosmagazine.com>

### New Research: Eating Grapes Can Protect Against UV Damage to Skin

2023-01-22

A recent study published in the journal Antioxidants has shown that consuming grapes can protect against UV damage to the skin. The study participants who consumed 2 ¼ cups of grapes daily for two weeks showed increased resistance to sunburn. The study also found a potential correlation between the gut and skin, as those participants who had UV resistance also had unique microbiomic and metabolomic profiles. The study suggests that the natural compounds called polyphenols found in grapes may be responsible for these protective effects.

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This new study reinforces previous research in this area. In this investigation with 29 human volunteers, researchers examined the impact of consuming whole grape powder – equivalent to 2 ¼ cups of grapes per day – for 14 days against photodamage from UV light. Subjects' skin response to UV light was measured before and after consuming grapes for two weeks by determining the threshold dose of UV radiation that induced visible reddening after 24 hours – the Minimal Erythema Dose (MED). Additionally, metabolomic analysis of the gut microbiome, blood, and urinary samples was undertaken.

Ultimately, one-third of the subjects demonstrated UV resistance following grape consumption, and these same subjects displayed significant differences in the microbiome and metabolome compared with the non-responders. Notably, the same three urinary metabolites were depressed in the UV-resistant group. One metabolite in particular (2'-deoxyribose) is a strong indicator of reduced photodamage and suggests unique genetic profiles of relevance for personalized medicine.

Furthermore, three of the UV-resistant subjects showed a durable response where UV protection remained after reverting back to no grape consumption for four more weeks. This work suggests that a segment of the population is capable of resisting sunburn following grape consumption and that there is a correlation between the gut-skin axis and UV resistance.

Over 3 million Americans are affected by skin cancer each year, largely as a result of exposure to sunlight. It is estimated that one in five Americans will develop skin cancer by the age of 70. Most skin cancer cases are associated with exposure to UV radiation from the sun: about 90 percent of nonmelanoma skin cancers and 86 percent of melanomas, respectively. Additionally, an estimated 90 percent of skin aging is caused by the sun.

John Pezzuto – lead author of the paper and professor and dean at Western New England University in Springfield, MA – notes “Let thy food be thy medicine and medicine be thy food’ dates back to the time of Hippocrates. Now, after 2500 years, as exemplified by this human study conducted with dietary grapes, we are still learning the reality of this statement.”

Sci Tech Daily, 22 January 2023

<https://scitechdaily.com>

**UV radiation can cause a variety of skin problems, including sunburn, premature aging, and skin cancer.**



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### Common Antidepressants Cause Emotional “Blunting” – Scientists Finally Figured Out Why

2023-01-22

Scientists have worked out why common anti-depressants cause around half of users to feel emotionally ‘blunted’. In a study published today, they show that the drugs affect reinforcement learning, an important behavioral process that allows us to learn from our environment.

According to the NHS, more than 8.3 million patients in England received an antidepressant drug in 2021/22. A widely-used class of antidepressants, particularly for persistent or severe cases, is selective serotonin reuptake inhibitors (SSRIs). These drugs target serotonin, a chemical that carries messages between nerve cells in the brain and has been dubbed the ‘pleasure chemical’. Common SSRIs include Citalopram (Celexa), Escitalopram (Lexapro), Paroxetine (Paxil, Pexeva), Fluoxetine (Prozac) and Sertraline (Zoloft).

One of the widely-reported side effects of SSRIs is ‘blunting’, where patients report feeling emotionally dull and no longer finding things as pleasurable as they used to. Between 40-60% of patients taking SSRIs are believed to experience this side effect.

To date, most studies of SSRIs have only examined their short-term use, but, for clinical use in depression, these drugs are taken chronically, over a longer period of time. A team led by researchers at the University of Cambridge, in collaboration with the University of Copenhagen, sought to address this by recruiting healthy volunteers and administering escitalopram, an SSRI known to be one of the best-tolerated, over several weeks and assessing the impact the drug had on their performance on a suite of cognitive tests.

In total, 66 volunteers took part in the experiment, 32 of whom were given escitalopram while the other 34 were given a placebo. Volunteers took the drug or placebo for at least 21 days and completed a comprehensive set of self-report questionnaires and were given a series of tests to assess cognitive functions including learning, inhibition, executive function, reinforcement behavior, and decision-making.

The results of the study are published today (January 23, 2023) in the journal *Neuropsychopharmacology*.

The team found no significant group differences when it came to ‘cold’ cognition – such as attention and memory. There were no differences

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in most tests of ‘hot’ cognition – cognitive functions that involve our emotions.

However, the key novel finding was that there was reduced reinforcement sensitivity on two tasks for the escitalopram group compared to those on placebo. Reinforcement learning is how we learn from feedback from our actions and environment.

In order to assess reinforcement sensitivity, the researchers used a ‘probabilistic reversal test’. In this task, a participant would typically be shown two stimuli, A and B. If they chose A, then four out of five times, they would receive a reward; if they chose B, they would only receive a reward one time out of five. Volunteers would not be told this rule, but would have to learn it themselves, and at some point in the experiment, the probabilities would switch and participants would need to learn the new rule.

The team found that participants taking escitalopram were less likely to use the positive and negative feedback to guide their learning of the task compared with participants on placebo. This suggests that the drug affected their sensitivity to the rewards and their ability to respond accordingly.

The finding may also explain the one difference the team found in the self-reported questionnaires, that volunteers taking escitalopram had more trouble reaching orgasm when having sex, a side effect often reported by patients.

Professor Barbara Sahakian, senior author, from the Department of Psychiatry at the University of Cambridge and a Fellow at Clare Hall, said: “Emotional blunting is a common side effect of SSRI antidepressants. In a way, this may be in part how they work – they take away some of the emotional pain that people who experience depression feel, but, unfortunately, it seems that they also take away some of the enjoyment. From our study, we can now see that this is because they become less sensitive to rewards, which provide important feedback.”

Dr. Christelle Langley, joint first author also from the Department of Psychiatry, added: “Our findings provide important evidence for the role of serotonin in reinforcement learning. We are following this work up with



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a study examining neuroimaging data to understand how escitalopram affects the brain during reward learning.”

Sci Tech Daily, 22 January 2023

<https://scitechdaily.com>

### How long does it take for skin to repair after sun exposure?

2023-01-24

It's impossible to avoid the Aussie sun entirely, but Australians are well aware of the dangers of too much exposure. Some 40 years of Slip Slop Slap (and more recently added, Seek and Slide) campaigns have reinforced this, not to mention the unpleasant experience of a sunburn most of us have encountered at some point.

Skin does repair itself, but how long does that take? If you hit the beach for half an hour, then retreat to the shade for a while, then go back out, will the damage have gone back to baseline? Or are you accumulating it?

Like most things, it's complicated.

#### How does the sun damage your skin?

Spending a day in the sun can cause 100,000 DNA defects in each exposed skin cell. DNA is the genetic information your body needs to build and run itself. There's a copy in each of your cells, except for red blood cells and the layer of dead cells at the very surface of the skin.

Your cells have a very effective DNA repair process, called nucleotide excision repair, for this kind of damage. But some damage still slips through the cracks.

When your skin's DNA monitoring system decides there is just too much damage to be effectively repaired, it tells the cells to self-destruct and calls in the immune system to finish them off. This causes the symptoms of sunburn: redness, pain, and sometimes blistering.

However, you don't have to get sunburnt to start accumulating damage. A tan is your skin reacting to DNA damage by increasing the amount of melanin, which alters the skin's colour, to mitigate future UV exposure. Though this only gives you the same protection as a 2-4 SPF sunscreen.

**Your cells have a very effective DNA repair process, called nucleotide excision repair, for this kind of damage. But some damage still slips through the cracks.**

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UV radiation in Australia is so high, particularly during summer, that you can start accumulating damage in the time it takes to hang out the washing or walk to the bus stop.

Even so, the amount of DNA damage is proportional to the amount of UV exposure, so longer exposures or exposures at high-UV times of day cause much more damage.

#### Remind me, what is UV radiation?

There are two types of UV radiation that damage skin – UVB mostly affects the upper layer, causing sunburn and skin cancer, and UVA mostly damages the lower layer, causing premature ageing.

These act in two different ways to damage skin, but due its cancer-causing properties, UVB is the better studied.

Light particles (UVB photons) discharge energy when they hit DNA. This causes bases on one DNA strand to connect to each other, instead of their corresponding bases on the other strand.

This distorts the DNA helix, so it doesn't copy correctly when it's time for the cells to divide.

And it causes permanent mutations that are replicated whenever the daughter cells multiply, setting the stage for skin cancers.

Even an exposure of half the amount of UV needed to cause a sunburn is enough to start generating these DNA defects.

#### How long does the damage take to repair?

Once they're formed, the half-life of DNA defects is 20-30 hours, depending on the efficiency of your own DNA-repair machinery. That means it takes 20-30 hours for your cells to repair even half the damage.

In one study that took samples at 24 and 72 hours after exposure, almost 25% of the damage detected at the 24-hour mark was still present at 72 hours.

So if you're already on your way to a sunburn, no, stepping away from the sun for 20 minutes to get an ice cream is not going to cut it. Your skin will eliminate most of the damage over a few days. But some may be missed or not found before the cell replicates.

You're better off minimising damage in the first place by planning to hit the beach early, spending the middle part of the day reading your new



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murder mystery in the shade, and perhaps returning to the sands from mid-afternoon.

Alternatively, you could extend your time in the sun by covering up extensively with a long-sleeved rashie, thick leggings, hat and frequently reapplied sunscreen on anything not covered up – and don't forget your feet!

### Get into the habit of wearing sunscreen every day

The good news is 30+ SPF sunscreen can steeply reduce and sometimes completely block damage.

To protect your skin, apply sunscreen as part of your morning routine on any day when the UV index is forecast to be 3 or higher. This will prevent an accumulation of damage from brief exposures like hanging out washing or walking in from the carpark.

Most weather forecasts will tell you what UV to expect but in Perth, Brisbane and Darwin it's over 3 all year around.

If you're going to be outside for a prolonged time, add sun protective clothing, a hat and sunglasses, reapply your sunscreen at least every two hours, and stay in the shade where possible.

If you do get sunburnt, the best thing you can do for yourself is stay out of the sun for a few days until the redness goes away. This lets your body deal with the damage as efficiently as possible without piling more on.

The Conversation, 24 January 2023

<https://theconversation.com>

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Growth and Volatile Organic Compound Production of Pseudomonas Fish Spoiler Strains on Fish Juice Agar Model Substrate at Different Temperatures

Toxicity of POEA-containing glyphosate-based herbicides to amphibians is mainly due to the surfactant, not to the active ingredient

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Airborne bacterial community and antibiotic resistome in the swine farming environment: Metagenomic insights into livestock relevance, pathogen hosts and public risks

Bacterial diversity in the aquatic system in India based on metagenome analysis-a critical review

### PHARMACEUTICAL/TOXICOLOGY

The partitioning and distribution of neonicotinoid insecticides in human blood

Association between Dietary Zinc Intake, Serum Zinc Level and Multiple Comorbidities in Older Adults

Risk Factors Involved in the High Incidence of Bladder Cancer in an Industrialized Area in North-Eastern Spain: A Case-Control Study

### OCCUPATIONAL

A cohort study of wastewater treatment plant workers: Association between levels of biomarkers of systemic inflammation and exposure to bacteria and fungi, and endotoxin as measured using two methods

Metabolic Changes and Their Associations with Selected Nutrients Intake in the Group of Workers Exposed to Arsenic