CHEMWATCH

Bulletin Board

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CONTACT US

subscribers@chemwatch.net
tel +61 3 9572 4700
fax +61 3 9572 4777

1227 Glen Huntly Rd
Glen Huntly
Victoria 3163 Australia

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ASIA PACIFIC

Australia's next step on forever chemicals

2022-10-02

There's an uncomfortable truth among experts who study a vast family of toxic, long-lived but widely used chemicals called PFAS.

It's that no-one knows how many there are, let alone the scope of their impacts on human and environmental health.

The Australian government, in its public health advice, talks about "more than 4000". The National Measurement Institute recently told a contamination conference it's more like 12,000.

Other researchers say it could be much higher because once PFAS chemicals are out in the world, they can create complex mixtures of intentionally-produced and unintentionally-generated PFAS compounds.

One certainty is that the man-made chemicals are now whirling around the planet and present in the bodies of pretty much every human, even those yet to be born.

Less than a fortnight ago, a team of researchers announced PFAS chemicals were detected in literally all of the 30,000 umbilical cord blood samples used in 40 different studies over the last five years.

Read More

Perthnow, 02-10-22

https://www.perthnow.com.au/news/environment/australias-next-step-on-forever-chemicals-c-8419186

Gardeners beware: household chemicals banned overseas are still used in Australia

2022-10-02

From tomato dust to snail pellets, Australia takes a much more relaxed approach to household pesticide use than other countries

When Kelvin McNickle discovered in his 30s he had non-Hodgkin lymphoma, he wondered whether it could be due to the Roundup he had used for more than a decade while clearing vegetation for councils.

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Now living in Queensland, he has become the lead plaintiff in a major class action being brought by Maurice Blackburn in Australia against chemical giant, Monsanto.

Monsanto, which was taken over by Bayer in 2018, was the original maker of glyphosate, the active ingredient in Roundup and Zero, two of the most popular products used in agriculture and gardens in Australia.

More than 700 people have now signed up to the Australian class action, which mirrors similar legal challenges around the world. It is currently scheduled for hearing in 2023.

Concerns about glyphosate crystallised in 2015 after a review by the World Health Organization's cancer research arm, the International Agency for Research on Cancer (IARC), concluded that glyphosate is "probably carcinogenic to humans".

This prompted the EU to renew its approval for use for five years instead of 15 in 2017. It is now under review again.

Read More

The Guardian, 02-10-22

https://www.theguardian.com/australia-news/2022/oct/02/gardeners-beware-household-chemicals-banned-overseas-are-still-used-in-australia

How big pesticide reaches into every element of rural life in Australia

2022-10-07

Like "big pharma" the global agricultural chemical companies run very sophisticated marketing and sponsorship networks that reach into almost every facet of rural life.

The agvet companies, as they are known, are major financial partners – whether it's funding for the conferences of agricultural organisations such as Cotton Australia and the National Farmers' Federation, or for university research and specialist advisory organisations such as WeedSmart.

German multinational Bayer, Swiss based Syngenta, Canadian based Nutrien, Adama (owned by Syngenta) US based Corteva (formerly Dow Dupont chemicals) and Australian company Nufarm contribute millions, if not billions, in support for rural activities.

They subsidise agronomists in rural towns. They provide scholarships at agricultural schools and fund farm safety programs.

They even fund government bodies, including – most controversially – providing 90% of the budget for Australia's pesticides regulator , the Australian Pesticides and Veterinary Medicines Authority, which operates on a user-pays basis.

What they do is not illegal. Some would say it's philanthropy. But it raises questions about whether organisations advising farmers, universities conducting research into improving crops, and even the regulator would be prepared to bite the hand that feeds them when it comes to pesticide use.

Read More

The Guardian, 7-10-22

https://www.theguardian.com/australia-news/2022/oct/07/how-big-pesticide-reaches-into-every-element-of-rural-life-in-australia

AMERICA

Boston bans artificial turf in parks due to toxic 'forever chemicals'

2022-09-30

Boston's mayor, Michelle Wu, has ordered no new artificial turf to be installed in city parks, making Boston the largest municipality in a small but growing number around the nation to limit use of the product because it contains dangerous chemicals.

All artificial turf is made with toxic PFAS compounds and some is still produced with ground-up tires that can contain heavy metals, benzene, VOCs and other carcinogens that can present a health threat. The material also emits high levels of methane, a potent greenhouse gas, and sheds microplastics and other chemicals into waterways.

"We already know there are toxic chemicals in the products, so why would we continue to utilize them and have children roll around on them when we have a safe alternative, which is natural grass?" asked Sarah Evans, an environmental health professor for the Icahn School of Medicine at Mount Sinai.

The city joins a growing number across the US in limiting the use of artificial turf made with dangerous PFAS compounds.

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Read More

The Guardian, 30-09-22

https://www.theguardian.com/environment/2022/sep/30/boston-bans-artificial-turf-toxic-forever-chemicals-pfas

More Suits, EPA Scrutiny Seen After Chemical Emissions Case

2022-10-05

A medical sterilizer plant's multi-million dollar loss in court over the carcinogenic effects of ethylene oxide sets the stage for an influx of similar cases and puts EPA actions on the potentially cancerous chemical under scrutiny.

Neighboring communities at the fence lines of facilities who use ethylene oxide—a compound used primarily to sterilize medical equipment—claim that emissions from the sterilization process cause short and long-term adverse health impacts, including cancer.

Those claims may have gotten a boost from a jury in Cook County, Ill., which ruled on Sept. 19 that medical sterilizer Sterigenics' Willowbrook plant emitted toxins that contributed to plaintiff Sue Kamuda's breast cancer over three decades. The plaintiff argued the company knew of the health hazards from the chemical, but didn't warn the community.

The $360 million win, which is the first jury verdict for these types of cases, could galvanize even more residents to file lawsuits against ethylene oxide emitters, according to David Fusco, partner at the K&L Gates LLP Pittsburgh office.

"The risk is real for variety of entities and the expected verdict is likely to lead an increase in litigation," Fusco told Bloomberg Law.

The Environmental Protection Agency is also facing legal action, with environmental groups threatening to sue the agency for missing a self-imposed deadline to revise existing sterilizer rules.The EPA has been touring the U.S. to inform communities about ethylene oxide risks, following an independent watchdog report that revealed the agency delayed critical risk disclosures for areas neighboring sterilization facilities.

Read More

Bloomberg Law, 5-10-22

https://news.bloomberglaw.com/environment-and-energy/more-lawsuits-epa-scrutiny-seen-after-chemical-emissions-case

New Online Tools Provide Communities with Information on Environmental Enforcement and Compliance

2022-10-05

The U.S. Environmental Protection Agency (EPA) announced on October 3, 2022, two new online tools available to the public that provide additional information on environmental enforcement and compliance in their communities. EPA states that through improved transparency, advanced technologies, and community participation, these tools empower the public to help EPA ensure compliance nationwide and protect public health and the environment.

EJ Metrics Integrated with ECHO

Members of the public can use EPA's Enforcement and Compliance History Online (ECHO) website to search for facilities in their communities to assess their compliance with environmental regulations. In addition, EPA has now integrated Environmental Justice (EJ) metrics in the basic ECHO facility features, allowing users to:

- Search for facilities in areas with possible EJ concerns;
- Investigate pollution sources in areas with possible EJ concerns;
- Examine and create EJ enforcement-related maps; and
- Analyze trends in compliance and enforcement EJ data.

EPA has posted a short video tutorial to help users get started: EJ and ECHO.

Read More

TSCA Blog, 5-10-22

https://www.tscablog.com/entry/new-online-tools-provide-communities-with-information-on-environmental-enfo

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EUROPE

Persistent pollutants: definition, effects and EU regulation

2022-10-06

As the EU moves towards a circular economy, which promotes the re-use and recycling of products, it is taking action to ensure toxic chemicals do not become concentrated in recycled materials. MEPs approved a revision of rules on persistent organic pollutants (POPs) in October 2022.

The new rules will further reduce the amount of dangerous chemicals in waste and production processes by introducing stricter limits, removing pollutants from the recycling chain and banning certain chemicals.

What are persistent organic pollutants?

Persistent organic pollutants are toxic chemicals that are slow to break down. When released, they stay in the environment for a long time and accumulate in the food chain and living organisms. That's why they are also sometimes referred to as forever chemicals.

Because of their persistence, these chemicals can be transported by water, air or migratory species across borders and carried far away from where they were first produced or used. They can also be transferred from one generation to the next, even if they are no longer produced or used.

This means that we can find such pollutants virtually everywhere: in our food, in the air we breathe, in products used in our daily lives such as paint, varnish and soap, and in waste coming from some consumer products such as waterproof textiles, furniture, plastics and electronic equipment.

Read More

The European Times, 6-10-22

https://www.europeantimes.news/2022/10/persistent-pollutants-definition-effects-and-eu-regulation/

INTERNATIONAL

UN expert committee backed for proposing global elimination of two highly toxic plastic additives.

2022-10-01

A UN expert scientific review committee has evaluated two toxic chemical additives found in many common plastics and has concluded the evidence of the substances harm to health and the environment qualify them for global elimination, recommending that the chemicals be listed under the Stockholm Convention on Persistent Organic Pollutants (POPs).

The Committee noted that it is important to separate out plastic wastes containing these chemicals, UV-328 and Dechlorane Plus, to ensure they are not recycled into new products. It also warned about the risk of replacing one of the chemicals, UV-328, with any other related hazardous chemical that could have harmful impacts on human health and the environment.

"We commend and support the proposals by the POPs Review Committee (POPRC) to list highly toxic plastic additives UV-328 and Dechlorane Plus for global elimination under the Stockholm Convention," said Aileen Lucero, National Coordinator, EcoWaste Coalition. "We hope governments will approve the recommendations, but turn down the suggested exemptions to put an end to the harms caused by the continued production and use of these POPs to human health and the environment."

Read More

Eco Waste Coalition, 01-10-22

https://ecowastecoalition.blogspot.com/2022/10/un-expert-committee-backed-for.html

Nigeria To Enforce Water Tests For Boreholes—Minister

2022-10-02

Plans to enforce a mandatory water test policy for the drilling of boreholes and other water projects are set to be implemented by the Nigerian Government.

This was contained in the announcement made by the Minister of Water Resources, Malam Suleiman Adamu on Sunday during the News Agency of Nigeria (NAN) interview forum in Abuja.

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Adamu said the policy is part of the Federal Government's efforts to strengthen its National Reference Laboratories to solve the problems of water quality, standards and monitoring in Nigeria. He stressed that periodic water tests and quality water surveillance were being carried out in adherence to the Nigerian Standard for Drinking Water Quality.

According to him, the ministry is equally giving priority to the completion of the National Reference Laboratories.

He said, "We are going to come up with a policy in all our water projects that when you drill boreholes, part of the condition is you must do water tests.

Read More

Sahara Reporters, 02-10-22

https://saharareporters.com/2022/10/02/nigeria-enforce-water-tests-boreholes-minister

Seaweed Food Safety Knowledge is Limited; FAO, WHO Call for Research, Regulation

2022-10-05

The Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) have released a report that reviews the current available information about the food safety of seaweed, both harvested from the wild and produced through aquaculture. The Report of the Expert Meeting on Food Safety for Seaweed—Current Status and Future Perspectives was compiled during a Joint FAO/WHO Expert Meeting on Seaweed Safety in October 2021.

The report raises a concern with the limited existing data on seaweed food safety, suggesting that the commodity may carry certain chemical, microbiological, physical, and allergen risks. The report recommends several actions to increase the safety of seaweed consumption while collecting more information about the product, aiming to support the development of appropriate Codex Alimentarius guidelines and regional regulations.

The consumption of seaweed has grown rapidly in recent years, according to the report. In 2018, global seaweed production exceeded 32 million tons, tripling from about 11 million tons in 2000. Since seaweed is a promising sustainable food crop, the report notes, the expansion of using seaweed as a food has been suggested. However, seaweed is known to

accumulate hazardous substances from the environment, which may pose risks to food safety. Additionally, despite the increasing global seaweed trade, there is no Codex standard or guidelines that specifically address the commodity's food safety, and national and regional regulatory harmonization is lacking.

Read More

Food Safety Magazine, 06-10-22

https://www.food-safety.com/articles/8036-seaweed-food-safety-knowledge-is-limited-fao-who-call-for-research-regulation

Publication of GB mandatory classification and labelling (GB MCL) Agency Opinions

2022-09-28

A GB MCL Agency Opinion formally proposes the GB mandatory classification and labelling for chemicals substances, based on the scientific and technical assessment of the scientific data in line with the GB CLP Regulation, together with an assessment of the policy and socio-economic impacts on the UK.

It sets out whether there is adequate scientific evidence to support a new or revised GB MCL of a substance and what the potential impact of the proposed GB MCL may be.

A new GB MCL Agency Opinion is now available for download in the GB MCL publication table (.xlsx).

This GB MCL Agency Opinion relates to a substance for which HSE (as the GB CLP Agency) published an Agency Technical Report under Article 37 of the GB CLP Regulation in September 2021.

At the time of publication, the classification and labelling proposed in this Agency Opinion has not been agreed and/or adopted in Great Britain.

For information on the next steps in the process, please see our webpage on the GB MCL system.

We expect to publish our next batch of Agency Opinions in November 2022. CLP ebulletin alerts will be issued when Agency Opinions are published on the HSE website.

If you have any questions or feedback on the GB MCL technical reports, please contact us at: GBCLP.GBMCL@hse.gov.uk

Journalists should contact HSE's press officefor further information.

Read More

HSE UK, 28-09-22

https://www.hse.gov.uk/

ECHA public consultation: call for comments

2022-09-28

Deadline: 21 October 2022

REACH Update

OCT. 14, 2022

The GB MCL process includes the consideration of information gathered from public consultations, conducted by HSE or international bodies such as the European Chemicals Agency (ECHA).

ECHA has announced a public consultation on the following proposals for harmonised classification and labelling (CLH):

- penconazole (ISO) (EC: 266-275-6; CAS: 66246-88-6).

Pesticide active substance. All hazard classes open for commenting

View the consultation on the ECHA website.

UK-based businesses with an interest in the proposals are strongly encouraged to share any relevant information.

Scientific and technical information should be submitted directly to ECHA using their commenting webform by 21 October 2022. Comments will be published on ECHA's website.

If your business is affected by the GB CLP Regulation, please also consider if you are likely to be affected by the classification and labelling proposal and let us know at an early stage if you anticipate any significant impacts or benefits.

Information on wider policy and impact considerations can be submitted to HSE at GBCLP.GBMCL@hse.gov.uk.

Under the GB CLP Regulation, HSE will consider all published opinions of the Committee of Risk Assessment of ECHA (RAC) before publishing its own Agency Technical Reports and Agency Opinions, so any information you provide will be important in any final GB MCL decision.

More information on the new GB MCL system is available on the HSE website.

Read More

HSE UK, 28-09-22

https://www.hse.gov.uk/

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Janet's Corner

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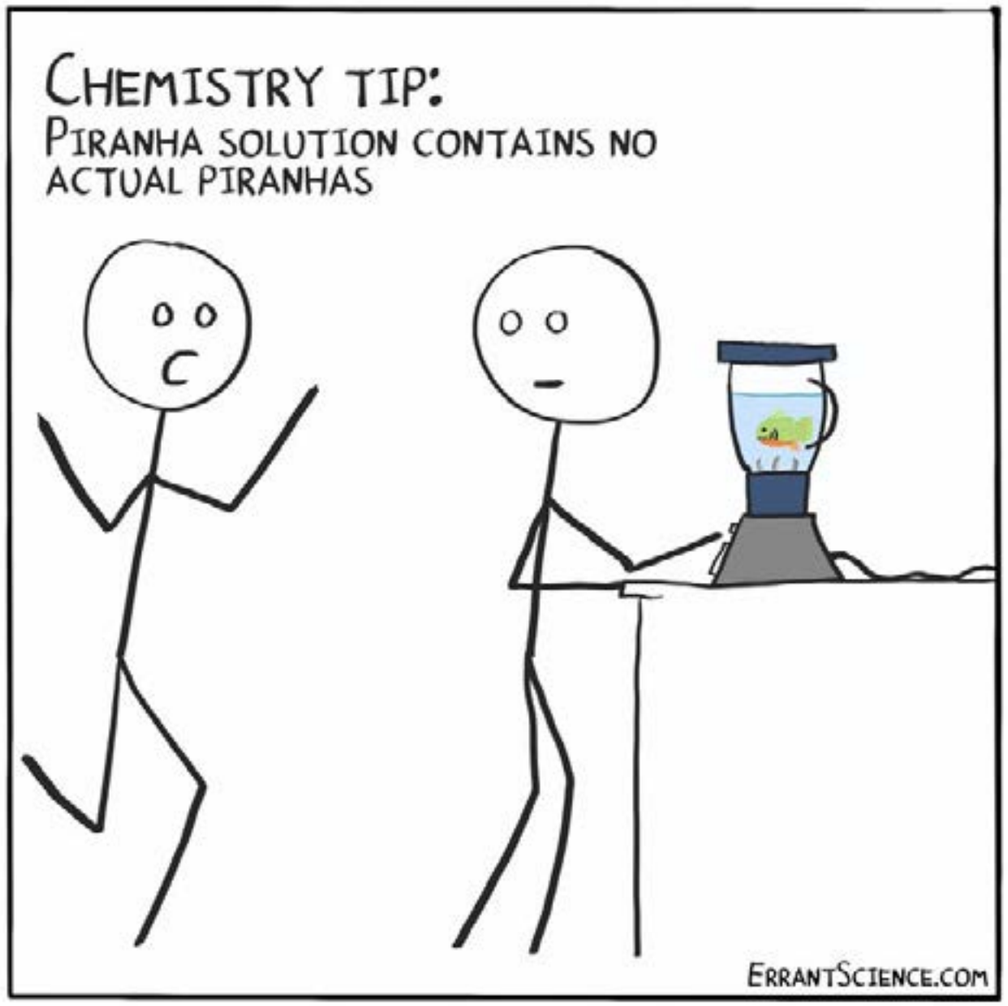
Piranha Solution

2022-10-14



https://twitter.com/ErrantScience/status/1574656481990942720

Methyl Chloride

2022-10-14

Methyl chloride—aka chloromethane—is a clear, colourless, and highly flammable gas. It is a naturally occurring ubiquitous gas, that has a faint, but sweet odour. Its chemical formula is CH3Cl. [1,2,3]

USES [1,3]

Methyl chloride is used across various industries. In the past it was used as a refrigerant and an anaesthetic. It is now used in the manufacture of silicone polymers, and as a methylating agent to attach CH3 to oxygen and nitrogen. Methyl chloride is also used as a solvent.

ROUTES OF EXPOSURE [4,5]

The primary route of exposure for methyl chloride is via inhalation.

Methyl chloride is made in the ocean by natural processes, meaning that it is present in the air all over the world. The outside air contains less than 1ppb of methyl chloride. Those who are most likely to be exposed to the chemical in the air are those who work in chemical plants where methyl chloride is being used.

HEALTH EFFECTS

Methyl chloride poisoning affects a range of systems including the integumentary and nervous systems.

Acute Effects [6]

Severity of symptoms depend on the level and type of exposure.

Acute methyl chloride poisoning can result in vomiting and convulsions, followed by an apparent recovery and then recurrence of these symptoms.

Other symptoms include: nausea, diarrhoea, abdominal pain.

Dermal exposure can cause irritation, vesiculation and erythema.

Dermal exposure to the liquid form of the chemical can result in frostbite.

Heavy, but acute poisoning can cause CNS depression, headaches, dizziness, weakness or paralysis, pulmonary oedema, drowsiness and a coma or death.

Methyl chloride—aka chloromethane—is a clear, colourless, and highly flammable gas.

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Chronic Effects [6]

Methyl chloride is toxic to multiple body systems. Long-term exposure to the chemical can result in blurred vision, confusion, numbness of extremities, ataxia, tremors, confusion and hallucinations. Symptoms of long-term poisoning can last several months.

SAFETY

First Aid Measures [7]

- Ingestion: Ingestion is not considered a potential route of exposure. However, if this chemical is ingested, DO NOT INDUCE VOMITING, and immediately contact a medical professional.
- Skin contact: The liquid form of this chemical may cause frostbite. For exposure to the liquid form, warm frostbitten area with water that does not exceed 41°C. Maintain skin temperature for at least 15 minutes, or until normal look, touch and temperature have returned. If there is heavy exposure, remove clothing while showering with warm water. Immediately contact a healthcare professional.
- Eye contact: Rinse eyes carefully with water for at least 15 minutes, ensuring to hold both eyelids open so they are flushed thoroughly. Contact an ophthalmologist immediately.
- Inhalation: Take victim to the nearest fresh air source and monitor their breathing. If they are not breathing, and you are qualified, you can administer CPR—with a pocket mask or one-way valve. Immediately contact a medical professional.
- General: Never administer anything by mouth to an unconscious, exposed person.

Exposure Controls/Personal Protection [7]

Engineering controls:

Emergency eyewash fountains and safety showers should be accessible in the immediate area of the potential exposure. Ensure there is adequate ventilation. Only use in conjunction with an explosion-proof local exhaust system, e.g. a fume hood.

Personal protection:

Safety glasses, protective and dustproof clothing, gloves, an apron and an appropriate mask. Follow the PPE guidelines set in your jurisdiction.

REGULATION [8]

United States:

The Occupational Safety and Health Administration (OSHA) has set an 8-hour time weighted average (TWA) concentration limit for methyl chloride of 100ppm.

Australia [9]

Safe Work Australia has set an 8-hour time TWA for ethyl chloride of 20ppm. They have set a Short Term Exposure Limit (STEL) of 80ppm.

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Biologists Create a New Type of Human Cells

2022-10-01

Professor Vincent Pasque and his colleagues at KU Leuven have used stem cells to create a new kind of human cell in the lab. The new cells closely mirror their natural counterparts in early human embryos. As a result, scientists are better able to understand what occurs just after an embryo implants in the womb. The was recently published in the journal Cell Stem Cell.

A human embryo implants in the womb around seven days after fertilization if everything goes correctly. Due to technological and ethical constraints, the embryo becomes unavailable for study at that point. That is why scientists have already created stem cell models for various kinds of embryonic and extraembryonic cells in order to investigate human development in a dish.

Vincent Pasque's team at KU Leuven has developed the first model for a specific type of human embryo cells, extraembryonic mesoderm cells. Professor Pasque: "These cells generate the first blood in an embryo, help to attach the embryo to the future placenta, and play a role in forming the primitive umbilical cord. In humans, this type of cell appears at an earlier developmental stage than in mouse embryos, and there might be other important differences between species. That makes our model especially important: research in mice may not give us answers that also apply to humans."

The new model cells aid in the study of early embryonic development.

The model cells were created by the researchers using human stem cells, which can still grow into all cell types in an embryo. The new cells closely resemble their natural counterparts in human embryos and hence serve as an excellent model for that cell type.

"You don't make a new human cell type every day," Pasque continues. "We are very excited because now we can study processes that normally remain inaccessible during development. In fact, the model has already enabled us to find out where extraembryonic mesoderm cells come from. In the longer term, our model will hopefully also shed more light on medical challenges such as fertility problems, miscarriages, and developmental disorders."

Sci Tech Daily, 1 October 2022

https://scitechdaily.com

Herpes virus genetically engineered to kill cancer

2022-09-26

Scientists have genetically modified a strain of the herpes virus to act as a cancer-killing agent in humans. Findings from an initial human trial are encouraging, with the experimental treatment proving safe and promisingly effective.

"Viruses are one of humanity's oldest enemies, as we have all seen over the pandemic," explained Kristian Helen from the Institute of Cancer Research. "But our new research suggests we can exploit some of the features that make them challenging adversaries to infect and kill cancer cells."

Called oncolytic viruses, researchers have long explored the potential for these tiny invaders to be recruited as cancer-killing soldiers. With the advent of genetic engineering over recent years scientists have finally been able to engineer viruses so they help instead of harm.

In this new research scientists have looked to modify a strain of the herpes simplex virus. The genetically modified virus, called RP2, has been engineered to only multiply within cancer cells, causing them to essentially inflate and explode.

The virus is designed to be directly injected into tumors and also act as an immune system alarm, attracting the body's own cancer-killing cells by producing molecules that spark immune activity.

"Our study shows that a genetically engineered, cancer-killing virus can deliver a one-two punch against tumors – directly destroying cancer cells from within while also calling in the immune system against them," said Kevin Harrington, a researcher working on the project.

Initial findings from the first Phase 1 trial testing the oncolytic therapy in 39 patients were announced at a recent medical conference in Europe. Three of nine patients testing the viral therapy on its own saw their tumors shrink, while seven of the remaining 30 saw treatment benefits in combination with other immunotherapy.

This Phase 1 trial was primarily focused on establishing whether the treatment is safe, and no serious adverse effects were detected. Because it was just a safety trial the patients recruited spanned a number of different cancer types, so future trials will better target the most effective cancers for this therapy.

Called oncolytic viruses, researchers have long explored the potential for these tiny invaders to be recruited as cancer-killing soldiers.

"It is rare to see such good response rates in early-stage clinical trials, as their primary aim is to test treatment safety and they involve patients with very advanced cancers for whom current treatments have stopped working," said Harrington. "I am keen to see if we continue to see benefits as we treat increased numbers of patients."

New Atlas, 26 September 2022

https://newatlas.com

1,000,000 Times Thinner Than a Single Strand of Hair – Scientists Develop Leak-Free Nano-Pipes

2022-10-01

Working on microscopic pipes just a millionth the width of a single strand of human hair, Johns Hopkins University researchers devised a method to protect these tiniest of pipelines against even the smallest of leaks.

Leak-free pipe constructed of self-assembling, self-repairing nanotubes that can link to different biostructures is a huge step toward developing a nanotube network that might one day carry specialized drugs, proteins, and molecules to specified cells in the human body. The highly precise measurements were recently outlined in Science Advances.

"This study suggests very strongly that it's feasible to build nanotubes that don't leak using these easy techniques for self-assembly, where we mix molecules in a solution and just let them form the structure we want," said Rebecca Schulman, an associate professor of chemical and biomolecular engineering who co-led the research. "In our case, we can also attach these tubes to different endpoints to form something like plumbing."

The scientists used tubes that were several microns long, or approximately the size of a dust particle, and had a diameter of seven nanometers, or about two million times smaller than an ant.

The technology is based on an existing technique that repurposes DNA fragments as building blocks to grow and repair the tubes while allowing them to seek out and connect to specific structures.

Similar structures have been created in earlier experiments to create smaller structures known as nanopores. These designs concentrate on DNA nanopores' ability to regulate the transport of molecules through lab-grown lipid membranes that resemble cell membranes.

[The] tubes are roughly seven nanometers in diameter — about two million times smaller than an ant — and several microns long, or about the length of a dust particle.

However, if nanotubes are like pipes, nanopores are like short pipe fittings that cannot reach other tubes, tanks, or equipment on their own. To solve these kinds of issues, Schulman's team specializes in bio-inspired nanotechnology.

"Building a long tube from a pore could allow molecules not only to cross the pore of a membrane that held the molecules inside a chamber or cell but also to direct where those molecules go after leaving the cell," Schulman said. "We were able to build tubes extending from pores much longer than those that had been built before that could bring the transport of molecules along nanotube 'highways' close to reality."

The nanotubes form using DNA strands that are woven between different double helices. Their structures have small gaps like Chinese finger traps. Because of the extremely small dimensions, scientists had not been able to test whether the tubes could transport molecules for longer distances without leaking or whether molecules could slip through their wall gaps.

Yi Li, a doctoral graduate from Johns Hopkins' chemical and biomolecular engineering department who co-led the study, performed the nano-equivalent of capping the end of a pipe and turning on a faucet to make sure no water leaks out. Yi capped the ends of the tubes with special DNA "corks," and ran a solution of fluorescent molecules through them to track leaks and influx rates.

By precisely measuring the shape of the tubes, how their biomolecules connected to specific nanopores, and how fast the fluorescent solution flowed, the team demonstrated how the tubes moved molecules into tiny, lab-grown sacks resembling a cell's membrane. The glowing molecules slid through like water down a chute.

"Now we can call this more of a plumbing system because we're directing the flow of certain materials or molecules across much longer distances using these channels," Li said. "We are able to control when to stop this flow using another DNA structure that very specifically binds to those channels to stop this transport, working as a valve or a plug."

DNA nanotubes could help scientists gain a better understanding of how neurons interact with one another. Researchers could also use them to study diseases like cancer, and the functions of the body's more than 200 types of cells.

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Next, the team will conduct additional studies with synthetic and real cells, as well as with different types of molecules.

Sci Tech Daily, 1 October 2022

https://scitechdaily.com

Quantum 'spooky action at a distance' lands scientists Nobel prize in physics

2022-10-05

The 2022 Nobel Prize in Physics has been awarded to three scientists whose work pioneered one of the most fascinating tests in the world of quantum mechanics, contradicting Einstein and discovering the strange phenomenon of quantum teleportation.

John F. Clauser, Alain Aspect, and Anton Zeilinger won the 10 million Swedish krona ($915,000) prize for "experiments with entangled photons, establishing the violation of Bell inequalities and pioneering quantum information science," the Royal Swedish Academy of Sciences, which is responsible for selecting the Nobel laureates in physics, announced Tuesday (Oct. 4).

They designed experiments that proved particles could affect each other instantaneously over vast distances.

The trio's work focuses on quantum entanglement, a process in which two or more quantum particles are coupled so that any change in one particle will lead to a simultaneous change in the other, even if they are separated by vast, even infinite, distances. This effect gives quantum computers the ability to perform multiple calculations simultaneously, exponentially boosting their processing power over those of conventional devices.

When the counterintuitive predictions proposed by quantum mechanics — of which quantum entanglement was one — were first discussed in 1935, not all physicists were comfortable with the implications. Albert Einstein dubbed the phenomenon "spooky action at a distance" and proposed that the effect actually came about because the particles contained hidden variables, or instructions, which had already predetermined their states. This would mean that there was no need for teleportation after all.

The three physicists who won today's prize demonstrated that Einstein was wrong. Their practical experiments, built upon foundations first established in the 1960s by the theoretical physicist John Stewart Bell, showed that the physical world is best described not by the discrete billiard ball model of Newtonian physics, but rather by a model of wave-

like particles that affect each other instantaneously across enormous distances.

"What today is considered logical, measurable and quantifiable was initially debated by Niels Bohr and Albert Einstein in philosophical terms. John Bell transformed the philosophical debate into science and provided testable predictions that launched experimental work," Eva Olsson, a member of the Nobel committee for Physics, said during the committee's announcement on Tuesday (Oct. 4). Olsson said that the three scientists who received this year's prize "took up the challenges of Bell and tackled them in their laboratories."

The work began in 1972, when John F. Clauser, an American physicist who is now the head of the J. F. Clauser and Associates research and consultancy firm, and his colleague Stuart Freedman devised the first test of Bell's ideas by colliding calcium atoms to emit pairs of entangled photons (light particles) before passing them through filters to hit detectors. This experiment successfully showed that the state of one photon depended on how the other, on the opposite side of the experiment, was measured, and that the change occurred faster than light could travel. "Spooky action at a distance" — their results suggested — could, in fact, be real.

But some critics pointed to loopholes in the design of Clauser's and Freedman's experiment. One of the most important was that the measurement was pre-set, with the filters which caused the photons to pick their state being fixed before the light particles were sent flying. This meant that hidden information might still exist, with the observers selecting only photons whose states appeared closely bound, and ruling out others that might demonstrate a different result.

In 1980, Alain Aspect, a physicist at the Université Paris-Saclay, Paris, refined the experiment, making it more efficient and using a device to randomly switch the configuration of the filters so that the outcome of any measurement was no longer even remotely influenced by the experimenters. The results were the same as before. The evidence overwhelmingly pointed to quantum mechanics being instantaneous in its reach.

Then, in 1989, Austrian physicist Anton Zeilinger, of the University of Vienna, built upon these foundations, using a more sophisticated experimental design to entangle multiple photons and even demonstrating that it is possible to move all of the information about one particle to another. Zeilinger also showed that the effect still took

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place across enormous distances, with entangled particles 89 miles (143 kilometers) apart still behaving according to quantum predictions. This work enabled the creation of ever larger quantum networks, marking the beginnings of today's fledgling quantum computers.

"Quantum information science is a vibrant and rapidly developing field. It has broad and potential implications in areas such as secure information transfer, quantum computing and sensing technology," Olsson said. "Its predictions have opened doors to another world, and it has also shaken the very foundations of how we interpret measurements."

Live Science, 5 October 2022

https://livescience.com

Study links in utero 'forever chemical' exposure to low sperm count and mobility

2022-10-05

A new peer-reviewed Danish study finds that a mother's exposure to toxic PFAS "forever chemicals" during early pregnancy can lead to lower sperm count and quality later in her child's life.

PFAS – per- and polyfluoroalkyl substances – are known to disrupt hormones and fetal development, and future "reproductive capacity" is largely defined as testicles develop in utero during the first trimester of a pregnancy, said study co-author Sandra Søgaard Tøttenborg of the Copenhagen University hospital.

"It makes sense that exposure to substances that mimic and interfere with the hormones involved in this delicate process can have consequences for semen quality later in life," Søgaard Tøttenborg said.

PFAS are a class of about 12,000 chemicals typically used to make thousands of products resistant to water, stains and heat. They are called "forever chemicals" because they accumulate in humans and the environment and do not naturally break down. A growing body of evidence links them to serious health problems such as cancer, birth defects, liver disease, kidney disease and decreased immunity.

The study, published on Wednesday in Environmental Health Perspectives, examined semen characteristics and reproductive hormones in 864 young Danish men born to women who provided blood samples during their pregnancies' first trimesters between 1996 and 2002.

PFAS, now found in nearly all umbilical cord blood around the world, interfere with hormones crucial to testicle development.

The study builds on others that found similar issues, but it is the first to look for exposure to more than two PFAS compounds and to assess exposure during early pregnancy, which is the male reproductive organ's "primary developmental period".

Researchers checked the mothers' blood for 15 PFAS compounds, and found seven in large enough concentrations to include in the study.

Those mothers with higher levels of exposure more frequently raised adult men with lower sperm counts, as well as elevated immotile sperm levels, meaning their sperm did not swim. This exposure also increased the amount of non-progressive sperm – sperm that do not swim straight or swim in circles. Both issues can lead to infertility.

The ubiquitous chemicals are estimated to be in 98% of Americans' blood, and they can cross the placental barrier and accumulate in the growing fetus. A recent analysis of 40 studies of umbilical cord blood from around the world found that PFAS were detected in all 30,000 samples collectively examined.

Infertility rates are on the rise worldwide, often for unclear reasons, Søgaard Tøttenborg said.

"The results of our studies are an important piece in that puzzle," she added. "Equally important: the more we know, the more we can prevent."

The Guardian, 5 October 2022

https://theguardian.com

Scientists Successfully Create Diamonds Out of Bottle Plastic

2022-10-03

What transpires inside planets like Uranus and Neptune? An innovative experiment was carried out to find out by a global team led by the Helmholtz-Zentrum Dresden-Rossendorf (HZDR), the University of Rostock, and France's École Polytechnique. They used intense laser flashes to study what occurred when they shot a laser at a thin sheet of simple PET plastic.

As a consequence, the scientists were able to support their prior hypothesis that diamonds really do rain within the ice giants at the edge of our solar system. Another was that this technique would provide a brand-new approach to making nanodiamonds, which are needed, for

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A research team utilizes laser flashes to replicate the interior of ice planets, which inspires a new method of creating tiny diamonds.

example, in very sensitive quantum sensors. The team's findings were recently published in Science Advances.

Extreme conditions occur in the interior of large icy planets like Neptune and Uranus, with pressure millions of times higher than on Earth and temperatures that can reach several thousand degrees Celsius. However, states like these can be briefly reproduced in the lab by using intense laser flashes to hit a sample of a film-like material, heat it to 6,000 degrees Celsius in the blink of an eye, and create a shock wave that compresses the material to a million times the atmospheric pressure for a few nanoseconds.

"Up to now, we used hydrocarbon films for these kinds of experiments," explains Dominik Kraus, a physicist at HZDR and professor at the University of Rostock. "And we discovered that this extreme pressure produced tiny diamonds, known as nanodiamonds."

However, since ice giants also contain significant quantities of oxygen, in addition to carbon and hydrogen, it was only partially able to replicate the interior of planets using these films. When looking for suitable film material, the researchers stumbled upon an everyday substance: PET, the resin used to make ordinary plastic bottles.

"PET has a good balance between carbon, hydrogen, and oxygen to simulate the activity in ice planets," Kraus explains.

The team carried out their research using the Linac Coherent Light Source (LCLS), a powerful, accelerator-based X-ray laser, at the SLAC National Accelerator Laboratory in California. They utilized it to analyze what transpires when powerful laser flashes hit a PET film while simultaneously using two measuring techniques: X-ray diffraction to detect if nanodiamonds were created and so-called small-angle scattering to see how fast and how big the diamonds grew.

Oxygen facilitates the process

"The effect of the oxygen was to accelerate the splitting of the carbon and hydrogen and thus encourage the formation of nanodiamonds," says Dominik Kraus, reporting on the results. "It meant the carbon atoms could combine more easily and form diamonds." This further supports the assumption that it literally rains diamonds inside the ice giants. The findings are probably not just relevant to Uranus and Neptune but to innumerable other planets in our galaxy as well. While such ice giants used

to be thought of as rarities, it now seems clear that they are probably the most common form of planets outside the solar system.

The team also encountered hints of another kind: In combination with the diamonds, water should be produced – but in an unusual variant. "So-called superionic water may have formed," Kraus opines. "The oxygen atoms form a crystal lattice in which the hydrogen nuclei move around freely." Because the nuclei are electrically charged, superionic water can conduct electric current and thus help to create the ice giants' magnetic field. In their experiments, however, the research group was not yet able to unequivocally prove the existence of superionic water in the mixture with diamonds. This is planned to happen in close collaboration with the University of Rostock at the European XFEL in Hamburg, the world's most powerful X-ray laser. There, HZDR heads the international user consortium HIBEF which offers ideal conditions for experiments of this kind.

Precision plant for nanodiamonds

In addition to this rather fundamental knowledge, the new experiment also opens up perspectives for a technical application: the tailored production of nanometer-sized diamonds, which are already included in abrasives and polishing agents. In the future, they are supposed to be used as highly-sensitive quantum sensors, medical contrast agents and efficient reaction accelerators, for splitting

CO2 for example. "So far, diamonds of this kind have mainly been produced by detonating explosives," Kraus explains. "With the help of laser flashes, they could be manufactured much more cleanly in the future."

The scientists' vision: A high-performance laser fires ten flashes per second at a PET film which is illuminated by the beam at intervals of a tenth of a second. The nanodiamonds thus created shoot out of the film and land in a collecting tank filled with water. There they are decelerated and can then be filtered and effectively harvested. The essential advantage of this method in contrast to production by explosives is that "the nanodiamonds could be custom cut with regard to size or even doping with other atoms," Dominik Kraus emphasizes. "The X-ray laser means we have a lab tool that can precisely control the diamonds' growth."

Sci Tech Daily, 3 October 2022

https://scitechdaily.com

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New tech could provide cheaper, less-polluting way to refine crude oil

2022-09-30

Despite efforts to pivot toward renewable sources of energy, oil remains the backbone of modern society. It provides fuels for heat and transportation, and chemicals for everything from plastics to pharmaceuticals. But all these uses require separating crude oil into its various components. That separation process—which traditionally relies on heat—takes a tremendous amount of energy and accounts for roughly 1% of global greenhouse gas emissions each year.

Now, chemists say a newly developed material might one day help lighten this significant—if largely invisible—carbon footprint, which consumes some 230 gigawatts annually, equivalent to the total energy consumption of Nevada. Researchers report this week that a novel membrane might, if scaled up, reduce the energy required to separate crude oil by more than half. Such membranes would not only make using crude oil greener, but also cheaper for refineries to produce, as it would save them billions of dollars a year in energy costs.

"The potential savings are pretty impressive," says Ryan Lively, a chemical engineer at the Georgia Institute of Technology who was not involved in the new work. The new membranes, he adds, must still prove to be durable for months if not years at a time. He and others also caution that conventional oil refineries may be slow to adopt them, because companies have already sunk costs into installing conventional separations systems. However, Lively says, the new membranes could quickly be adopted in new refineries built to separate hydrocarbon mixtures created from biofuels or synthetic fuels made using renewable electricity. "That's really ripe territory," Lively says.

Crude oil is a mixture of tens of thousands of chemicals. The first step in petroleum refining is separating that mix through a distillation process. The raw crude oil is heated up to about 500°C. Lighter components, such as those that make up gasoline, vaporize at lower temperatures and are captured. Heavier components, such as home heating oil, vaporize at higher temperatures.

Two years ago, researchers led by Lively and Andrew Livingston, a chemical engineer at Queen Mary University of London, reported in Science that it was possible to separate out these components using membranes rather than distillation. They created membranes with built-in

That separation process—which traditionally relies on heat—takes a tremendous amount of energy and accounts for roughly 1% of global greenhouse gas emissions each year.

pores that allow small, light hydrocarbons to pass through and keep larger, heavier ones out. But light hydrocarbons passed through the membranes too slowly to make them practical for real-world use.

To get around this, Livingston and his colleagues turned to an industrial approach for making ultrathin water desalination membranes called interfacial polymerization. They hoped thinner membranes would enable the desired hydrocarbons to pass through more quickly. However, Livingston notes, while the membranes typically used for desalination are sturdy in a water-based environment, they quickly fall apart when subjected to hydrocarbons that include industrial solvents.

So, he and colleagues reformed the polymers that make up conventional membranes. First, they made individual polymers, linking a hydrophobic, or oil-like portion, to a hydrophilic, or waterlike strand. When they added these molecules in a mix of oil and water, they spontaneously assembled into tiny bubbles, or vesicles, with the hydrophobic portion facing inward. They then used the interfacial polymerization technique to spread these vesicles into a continuous ultrathin sheet and link all the polymer units together to form a robust membrane.

The approach worked. The hydrophobic cores of the vesicles allowed selected (based on size and other characteristics) hydrocarbons to pass through readily—some 10 times faster than in previous oil-separation membranes, Livingston and his colleagues reported yesterday in Science. The researchers also showed that by tailoring the chemical makeup of the polymers, they could create different membranes that selectively pass through hydrocarbons of different sizes.

According to Neel Rangnekar, a chemical engineer with Exxon and a team member on the new paper, switching from distillation to membrane separation could save up to 50% of the cost of heating the crude oil and 75% of the cost of electricity used in refining, amounting to at least $3.5 billion per year.

“It’s a very exciting result,” says David Sholl, a separations expert at Oak Ridge National Laboratory who was not involved with the study. However, Sholl notes, the novel membranes aren’t yet ready for industrial use. They still need to be scaled up from the size of a piece of writing paper to hundreds of square meters and prove durable for months of continuous use. But Sholl thinks these encouraging findings will ensure oil companies will continue to explore a technology that could both save money and

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reduce their carbon emissions. “All chemical companies are extremely interested in trying to do that,” he says.

Science, 30 September 2022

https://science.org

Nicole Mann becomes first Native American woman in space on Crew-5 mission

2022-10-06

Nicole Mann has become the first Native American woman in space as she lifted off in command of a flight to the International Space Station on Wednesday that also included the first Russian to join a US space flight since the invasion of Ukraine.

Mann’s journey on the launch vehicle, which consists of a SpaceX Falcon 9 rocket topped with a Crew Dragon capsule named Endurance, took off on schedule at noon from Nasa’s Kennedy Space Center in Cape Canaveral, Florida.

The four-member crew is scheduled to arrive at the ISS after about 29 hours, on Thursday evening, to begin a 150-day science mission aboard the orbital laboratory 250 miles (420km) above Earth.

The mission, designated Crew-5, marks the fifth full-fledged ISS crew Nasa has flown aboard a SpaceX vehicle since the private rocket venture, founded by the Tesla owner, Elon Musk, began sending US astronauts aloft in May 2020.

Mann, 45, is a veteran combat pilot who has made spaceflight history not just as the first indigenous woman in orbit but as the first woman to command a Crew Dragon capsule.

Her team includes the Russian cosmonaut Anna Kikina, who is hitching a ride alongside the American astronaut Josh Cassada and Japan’s Koichi Wakata.

Mann is a US Marine Corps colonel who flew combat missions in Iraq and Afghanistan and holds a master’s degree in engineering, specializing in fluid mechanics.

She is a registered member of the Wailacki of the Round Valley Indian Tribes. The only other Indigenous American to have entered orbit is John Herrington, who flew on a 2002 shuttle mission.

SpaceX Falcon 9 rocket with quartet including first Russian to join US space flight since Ukraine invasion.

"I feel very proud," Mann said of her historic trip before lift-off. "It's important that we celebrate our diversity and really communicate that specifically to the younger generation."

Referring to the excitement that her trip has generated among some Native American communities, she said: "That's really, I think, an audience that we don't get an opportunity to reach out to very often."

The Crew-5 mission is also notable for the inclusion of Kikina, 38, the lone female cosmonaut on active duty for the Russian space agency Roscosmos, and the first Russian to fly onboard an American spacecraft since Russia invaded Ukraine in February. The last Russian cosmonaut to ride a US rocket into orbit was in 2002, on a Nasa space shuttle.

Kikina is swapping places with a Nasa astronaut who took her seat onboard a Russian Soyuz flight to the ISS last month, under a new ride-sharing deal signed by Nasa and Roscosmos in July.

She would be only the fifth Russian woman in space. "In general, for me, it doesn't matter," she explained in a recent interview. "But I realize the responsibility for it because I represent the people of my country."

The Crew-5 team will be welcomed by seven existing ISS occupants – the Crew-4 team consisting of three Americans and an Italian astronaut, as well as two Russians and a Nasa astronaut who flew with them to orbit on a Soyuz flight.

The new arrivals are tasked with conducting more than 200 experiments, many of them focused on medical research ranging from 3-D bio-printing of human tissue to the study of bacteria cultured in microgravity.

US-Russian space cooperation has been tested as never before since Russia invaded Ukraine in February, leading the Biden administration to impose sweeping sanctions against Moscow.

During a news briefing with Nasa and SpaceX on Monday, a high-ranking Roscosmos official, Sergei Krikalev, said his agency has approval to continue with the ISS until 2024 and hopes to secure Kremlin "permission" to extend the partnership further, until Russia builds a new space station.

Nasa hopes to keep the ISS running with its existing partners until roughly 2030.

The Guardian, 6 October 2022

https://theguardian.com

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New RNA Tool Can Illuminate Brain Circuits and Edit Specific Cells

2022-10-05

Scientists at Duke University have developed an RNA-based editing tool that targets individual cells, rather than genes. It is capable of precisely targeting any type of cell and selectively adding any protein of interest.

Researchers said the tool could enable modifying very specific cells and cell functions to manage disease.

Using an RNA-based probe, a team led by neurobiologist Z. Josh Huang, Ph.D. and postdoctoral researcher Yongjun Qian, Ph.D. demonstrated they can introduce into cells fluorescent tags to label specific types of brain tissue; a light-sensitive on/off switch to silence or activate neurons of their choosing; and even a self-destruct enzyme to precisely expunge some cells but not others. The work will be published today (October 5, 2022) in the journal Nature.

Their selective cell monitoring and control system relies on the ADAR enzyme, which is found in every animal's cells. While these are early days for CellREADR (Cell access through RNA sensing by Endogenous ADAR), the possible applications appear to be endless, Huang said, as is its potential to work across the animal kingdom.

"We're excited because this provides a simplified, scalable and generalizable technology to monitor and manipulate all cell types in any animal," Huang said. "We could actually modify specific types of cell function to manage diseases, regardless of their initial genetic predisposition," he said. "That's not possible with current therapies or medicine."

CellREADR is a customizable string of RNA made up of three main sections: a sensor, a stop sign, and a set of blueprints.

First, the research team decides what specific cell type they want to investigate, and identifies a target RNA that is uniquely produced by that cell type. The tool's remarkable tissue specificity relies on the fact that each cell type manufactures signature RNA not seen in other cell types.

A sensor sequence is then designed as the target RNA's complementary strand. Just as the rungs on DNA are made-up of complementary molecules that are inherently attracted to each other, RNA has the same magnetic potential to link with another piece of RNA if it has matching molecules.

Editing technology is precise and broadly applicable to all tissues and species.

After a sensor makes its way into a cell and finds its target RNA sequence, both pieces glom together to create a piece of double-stranded RNA. This new RNA mashup triggers the enzyme ADAR to inspect the new creation and then change a single nucleotide of its code.

The ADAR enzyme is a cell-defense mechanism designed to edit double-strand RNA when it occurs, and is believed to be found in all animal cells.

Knowing this, Qian designed CellREADR's stop sign using the same specific nucleotide ADAR edits in double-stranded RNA. The stop sign, which prevents the protein blueprints from being built, is only removed once CellREADR's sensor docks to its target RNA sequence, making it highly specific for a given cell type.

Once ADAR removes the stop sign, the blueprints can be read by cellular machinery that builds the new protein inside the target cell.

In their paper, Huang and his team put CellREADR through its paces.

"I remember two years ago when Yongjun built the first iteration of CellREADR and tested it in a mouse brain," Huang said. "To my amazement, it worked spectacularly on his first try."

The team's careful planning and design paid off as they were then able to demonstrate CellREADR accurately labelled specific brain cell populations in living mice, as well as effectively added activity monitors and control switches where directed. It also worked well in rats, and in human brain tissue collected from epilepsy surgeries.

"With CellREADR, we can pick and choose populations to study and really begin to investigate the full range of cell types present in the human brain," said co-author Derek Southwell, M.D., Ph.D., a neurosurgeon and assistant professor in the department of neurosurgery at Duke.

Southwell hopes CellREADR will improve his and others' understanding of the wiring diagram for human brain circuits and the cells within them, and in doing so, help advance new therapies for neurological disorders, such as a promising new method to treat drug-resistant epilepsy he is piloting.

Huang and Qian are especially hopeful about CellREADR's potential as a "programmable RNA medicine" to possibly cure diseases — since that's what drew them both to science in the first place. They have applied for a patent on the technology.

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"When I majored in pharmacology as an undergraduate, I was very naïve," Qian said. "I thought you could do a lot of things, like cure cancer, but actually it's very difficult. However, now I think, yes maybe we can do it."

Sci Tech Daily, 5 October 2022

https://scitechdaily.com

What position should I sleep in, and is there a 'right' way to sleep?

2022-09-28

After 50 years of research, eminent Stanford University sleep researcher William Dement reportedly said the only solid explanation he knows for why we sleep is "because we get sleepy".

Even though sleep may be, as one researcher put it, "the only major behaviour in search of a function", it clearly does matter for our health and wellbeing.

But are we doing it right? What does the research say about sleeping position?

Is there a correct position to sleep in?

Most people prefer to sleep on their side. This is good to hear, as those who lie on their backs are more likely to be poor sleepers or have breathing difficulties during the night.

In most cases, we tend to move around quite a lot during the night. One study of 664 sleepers found, on average, that participants spent about 54% of their time in bed sleeping on their side, about 37% on their back, and about 7% on their front.

Males (especially those aged under 35) tend to be most restless, with more position shifts, and arm, thigh, and upper-back movements during the night.

This may not be a bad thing, as allowing your body to move during the night is generally a good idea.

During sleep, your body will keep track of any pain or discomfort and adjust position accordingly. This is why we usually avoid developing bedsores (or pressure ulcers) in everyday life.

After 50 years of research, […] the only solid explanation for why we sleep is "because we get sleepy".

If you find you can't move because your partner (or dog) is taking up too much room in the bed, consider switching sides or getting a larger bed.

And don't tuck yourself in too tightly; give yourself some room to move around on either side.

Being comfortable is key. There is no quality research providing clear evidence for an "optimal sleep position". Your age, weight, environment, activities and whether you're pregnant, all play a role in which sleep position is best for your body.

Ideally, we can find a position that helps us get a good night's sleep, and one that avoids us waking up in any pain.

Even with our chosen position, some layouts are better than others. In one study, people who rested in a position where there is a rotation of the spine (such as the unsupported side position), woke up with more pain in the morning.

Nonetheless, although some forms of side-sleeping may cause a bit of load on the spine, it appears the side positions, in general, are still better than the other options.

What pillow should I choose?

Choosing the right pillow is vital for a good night's sleep.

A lack of support for the head and neck during sleep has been found to severely impact spine alignment, and cause muscle problems such as neck pain, shoulder pain and muscle stiffness.

Promisingly, the pillow material does not appear to affect the spine. Instead, the shape and the height is what matters. A U-shaped pillow may help you have a longer night's sleep, and a roll-shaped pillow can reduce morning pain and bedtime pain in those suffering from chronic pain.

Unfortunately, science has not given us an answer on what is the optimal mattress. With everyone sleeping differently, this would be hard to compare over the long term.

However, there are bad mattresses. If your bed is sagging, has lost its firmness, develops noisy springs, or shows clear signs of wear and tear, consider changing your mattress.

Rotating the mattress can help with its longevity and improve comfort. This should be done at least one to two times per year.

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Other tips for a restful night's sleep

Set a cooler room temperature. The ideal temperature for sleep is 18.3 (ranging between 15-19); higher temperatures can affect sleep.

Allow some airflow in the room. Besides bringing nice, fresh air, it also clears away any accumulated heat, keeping us nice and cool during the night.

Some medications, such as certain types of antihistamines, may make it easier to get to sleep. On the other hand, stimulants such as caffeine can drastically affect the quality of your sleep.

Finally, be sure not to go to bed with a full bladder, as having to get up at night to wee can impact sleep.

The Conversation, 28 September 2022

https://theconversation.com

Biologists Use Genetic Circuits to Program Plant Roots

2022-09-28

When the physicist Richard Feynman died in 1988, he left a note on his blackboard that read, "What I cannot create, I do not understand." Feynman may have been reflecting on the nature of scientific understanding, but the sentiment also reflects the spirit of synthetic biology. That scientific field is all about deconstructing and precisely manipulating biological processes to test our grasp of them.

"Everyone in synthetic biology loves that quote," said Patrick Shih, a synthetic plant biologist at the University of California, Berkeley. "It's pretty much the central tenet."

New work in plants marks an important advance toward realizing synthetic biology's most ambitious goals. A study published last month in Science created a kind of genetic circuit in plant roots, in effect programming how they grow. Stanford University researchers, led by Jennifer Brophy, a bioengineer, and José Dinneny, a plant systems biologist, developed a genetic toolkit to control whether the root systems of two plant species grew more laterally or horizontally and how much the roots branched. Their work confirms genetic models of plant growth and shows for the first time that it's possible to program functional patterns of gene activity over time in specific tissues of complex organisms.

The new genetic toolkit should be very useful to other synthetic biologists in their own future experiments. However, the results of the researchers' experiments weren't as straightforward as Brophy and her colleagues had hoped, showing the challenges of applying digital logic gates to messy living systems.

Rewiring Root Growth

Although synthetic biologists have been inserting genetic control systems into bacteria and cultured complex cells for about two decades, technical issues have made it much harder for them to do this with complex multicellular organisms like plants. So to construct their biological circuit, Brophy, Dinneny and their coworkers assembled and refined a suite of molecular tools, including pieces of modified viruses and of bacteria that cause tumors in plants. Synthetic biologists often create the techniques and genetic elements they need as one-offs for specific organisms and experiments, but the Stanford team was more interested in assembling a general-purpose toolkit that can be adapted for different organisms as needed.

The researchers created synthetic promoter elements that, like on/off switches, would bind to various targeted genes involved in root growth and activate them.

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With this customizable toolkit, the researchers tailored genetic circuits to their specific organisms. In this case, they used two popular model organisms — Arabidopsis thaliana, a relative of mustard plants, and Nicotiana benthamiana, a cousin of tobacco.

The researchers created synthetic promoter elements that, like on/off switches, would bind to various targeted genes involved in root growth and activate them. They then linked these control elements to one another like Boolean logic gates in a programmable circuit. The controls enabled the researchers to recruit the plant's own proteins to drive — or inhibit — root growth.

They made the plants express a wide range of programmed root variation, from a sprawling spider web of root hairs to a single, long taproot. Their goal was to demonstrate flexible control, rather than to produce a specific desired result. "It's a proof of concept," said Olivier Martin, a researcher at the French National Research Institute for Agriculture, Food and Environment who was not involved in the new research.

Control over the growth of root systems could be revolutionary for agriculture, especially in drought-stricken regions, where life may become more dire with ongoing climate change. Crops could be programmed to grow shallow root systems to quickly soak up heavy but infrequent rains, or to send their roots straight down and keep them closely packed together to avoid infringing on a neighbor's space.

The applications aren't limited to agriculture. Plants are "nature's chemists," Martin said. "They produce an incredible diversity of compounds." Harnessing that ability through synthetic biology could enable researchers to produce new pharmaceuticals at a large scale.

Fighting Inconsistency

But the fruits of synthetic plant biology aren't ready to hit the farmers market or drugstore shelves just yet. Even though most of the plants in the Stanford experiments behaved in accordance with their programming, their gene expression was not quite as black and white as the researchers had hoped. "Even calling it Boolean or digital is tough because the 'off' states are not completely off, and the 'on' states are relative," Brophy said.

In the roots, an "off" state was indicated by a complete root cap, a layer of cells on the tip of a root tendril that prevents further growth. "On" states were simply defined by the presence of a root or rootlet. But the researchers observed that some roots in the "off" state only developed a

partial root cap — enough to stop growth after a certain point, but not enough to prevent it altogether. These aberrant expressions cropped up most often when the team applied a logic gate developed for the Nicotiana to an Arabidopsis plant; they tended to disappear after the toolkit was tweaked for Arabidopsis genes.

Although this kind of partial expression adds to the challenges that synthetic biology faces, Shih said that it might have advantages too: It may make plants easier subjects for experimental tests than animals since partial gene expression in animals is often less obvious (and more fatal).

Devang Mehta, a systems biologist at the University of Alberta in Canada who was not involved in the study, calls Brophy and Dinneny's research a "big step forward" in organismal synthetic biology. However, he cautions that we shouldn't underestimate how challenging the next step will be.

"Things like Boolean logic in particular are very useful in contained environments, where you can really control environmental variables," said Mehta. "This is a lot harder to do in a natural environment."

That's because plants and other living things are highly responsive to their environment in ways that computers aren't, which complicates the challenge of programming them with reliable genetic circuits. Brophy contrasts them to a calculator, for which 2 plus 2 equals 4 every time. "It would be problematic if 2 plus 2 equaled 3 when it was cold, and 5 when it was too bright," she said. To implement a Boolean gene circuit in crops like corn or wheat growing in a field, synthetic biologists must either devise a way to control the weather or, more realistically, prevent the plants from responding as strongly to heat, cold and rain.

"That's an important limitation that the field needs to be very upfront about," Shih said. He sees Brophy and Dinneny's work as a preliminary road map for addressing this challenge. "Now we can see which [tools] work, and which ones don't."

Quanta Magazine, 28 September 2022

https://quantamagazine.org

'Love hormone' is revealed to have heart healing properties

2022-09-30

The neurohormone oxytocin is well-known for promoting social bonds and generating pleasurable feelings, for example from art, exercise, or

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sex. But the hormone has many other functions, such as the regulation of lactation and uterine contractions in females, and the regulation of ejaculation, sperm transport, and testosterone production in males.

Now, researchers from Michigan State University show that in zebrafish and human cell cultures, oxytocin has yet another unsuspected function: It stimulates stem cells derived from the heart's outer layer (epicardium) to migrate into its middle layer (myocardium) and there develop into cardiomyocytes, muscle cells that generate heart contractions. This discovery could one day be used to promote the regeneration of the human heart after a heart attack. The results are published in Frontiers in Cell and Developmental Biology.

"Here we show that oxytocin, a neuropeptide also known as the love hormone, is capable of activating heart repair mechanisms in injured hearts in zebrafish and human cell cultures, opening the door to potential new therapies for heart regeneration in humans," said Dr. Aitor Aguirre, an assistant professor at the Department of Biomedical Engineering of Michigan State University, and the study's senior author.

Oxytocin, a neuropeptide also known as the love hormone, is capable of activating heart repair mechanism.

Stem-like cells can replenish cardiomyocytes

Cardiomyocytes typically die off in great numbers after a heart attack. Because they are highly specialized cells, they can't replenish themselves. But previous studies have shown that a subset of cells in the epicardium can undergo reprogramming to become stem-like cells, called Epicardium-derived Progenitor Cells (EpiPCs), which can regenerate not only cardiomyocytes, but also other types of heart cells.

"Think of the EpiPCs as the stonemasons that repaired cathedrals in Europe in the Middle Ages," explained Aguirre.

Unfortunately for us, the production of EpiPCs is inefficient for heart regeneration in humans under natural conditions.

Zebrafish could teach us how to regenerate hearts more efficiently

Enter the zebrafish: famous for their extraordinary capacity for regenerating organs, including the brain, retina, internal organs, bone, and skin. They don't suffer heart attacks, but its many predators are happy to take a bite out of any organ, including the heart—so zebrafish can regrow their heart when as much as a quarter of it has been lost. This is done partly by proliferation of cardiomyocytes, but also by EpiPCs. But how do the EpiPCs of zebrafish repair the heart so efficiently? And can we find a

"magic bullet" in zebrafish that could artificially boost the production of EpiPCs in humans?

Yes, and this "magic bullet" appears to be oxytocin, argue the authors.

To reach this conclusion, the authors found that in zebrafish, within three days after cryoinjury—injury due to freezing—to the heart, the expression of the messenger RNA for oxytocin increases up to 20-fold in the brain. They further showed that this oxytocin then travels to the zebrafish epicardium and binds to the oxytocin receptor, triggering a molecular cascade that stimulates local cells to expand and develop into EpiPCs. These new EpiPCs then migrate to the zebrafish myocardium to develop into cardiomyocytes, blood vessels, and other important heart cells to replace those that had been lost.

Similar effect on human tissue cultures

Crucially, the authors showed that oxytocin has a similar effect on human tissue in vitro. Oxytocin—but none of 14 other neurohormones tested here—stimulates cultures of human Induced Pluripotent Stem Cells (hIPSCs) to become EpiPCs, at up to twice the basal rate: a much stronger effect than other molecules previously shown to stimulate EpiPC production in mice. Conversely, genetic knock-down of the oxytocin receptor prevented the the regenerative activation of human EpiPCs in culture. The authors also showed that the link between oxytocin and the stimulation of EpiPCs is the important "TGF-β signaling pathway," known to regulate the growth, differentiation, and migration of cells.

Aguirre said, "These results show that it is likely that the stimulation by oxytocin of EpiPC production is evolutionary conserved in humans to a significant extent. Oxytocin is widely used in the clinic for other reasons, so repurposing for patients after heart damage is not a long stretch of the imagination. Even if heart regeneration is only partial, the benefits for patients could be enormous."

"Next, we need to look at oxytocin in humans after cardiac injury. Oxytocin itself is short-lived in the circulation, so its effects in humans might be hindered by that. Drugs specifically designed with a longer half-life or more potency might be useful in this setting. Overall, pre-clinical trials in animals and clinical trials in humans are necessary to move forward," concluded Aguirre.

Phys Org, 30 September 2022

https://phys.org

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Do human embryos and cancer share the same starting fuse?

2022-10-03

At the moment of fertilization, the genes in the fertilizing sperm and egg are switched off. For a new embryo to develop, they must be switched on—but how?

The answer is unknown, which seems remarkable for such a fundamental event at the beginning of embryonic life, and for decades, it was thought that genes in human embryos were silent for several days after fertilization. Recent findings, however, show they are switched on almost immediately.

Now that this is recognized, scientists have produced perhaps the first model of how the switch works to initiate embryonic development.

The model has been developed by Professor Tony Perry from the Department of Life Sciences at the University of Bath, with colleagues Dr. Maki Asami, also at Bath, and Dr. Brian Lam and Professor Giles Yeo at the University of Cambridge. Their work is published in this month's Trends in Cell Biology.

The model suggests that the myriad events that accompany fertilization act synergistically to switch on embryo gene expression. To emphasize that the switch occurs at the start of development, the piece borrows from "Under Milk Wood," by Dylan Thomas: "To begin at the beginning."

Professor Perry and colleagues have extended the model to predict something quite startling: that the switch that begins embryo formation may also initiate cancer.

The start of cancer and embryonic life

Often, by the time cancer is diagnosed, the disease is already advanced and, in some cases, time is running out. We know little about how many cancers begin. It may be like lighting the blue touch paper of a firework, which is long gone when by the time see the sparkling array of colors. How can we discover the nature of this fuse, so that as soon as it is lit, we can detect it and put it out before cancer develops?

This is where a better understanding of the beginning of embryonic life fits in. The genes in an embryo need a switch to get going after fertilization, like the touch paper in cancer.

At the moment of fertilization, the genes in the fertilizing sperm and egg are switched off. For a new embryo to develop, they must be switched on—but how?

Professor Perry and his team have previously found that the switch in embryos involves genes, called oncogenes, that play key roles in cancer.

There are many processes and players involved in embryo development whose roles we do not yet understand. For example, we don't know how the starter switch is activated.

"The switch that activates embryo gene expression is probably linked to changes in the way the embryonic genome is packaged, called epigenetic changes, but we don't know what these changes are or how they are controlled," said Professor Perry. How can this incomplete idea about embryos be used to understand cancer?

Using embryos to understand the origins of cancer

The process of fertilization is predictable, and the formation of a new embryo (for example, a mouse embryo) can be studied at all stages in a dish. This is not the case for cancer, whose origins cannot yet be studied in the controlled environment of a laboratory. Studying embryos allows us to identify the embryonic switch and reveal how it is activated. This will show us where to look to illuminate the origin of cancer: the lighting of the blue touch paper.

"This approach is promising given that we currently have no way of studying the initiating events of cancer," said Professor Perry.

"In molecular terms, we don't even know what the blue touch paper looks like. Understanding the switch that starts a new embryo provides an experimental platform to reveal how the fuse is lit in cancer."

The idea is at an early stage, but it starts with a model of how healthy embryos are naturally formed: to begin at the beginning. If correct, the model will open a new and exploitable window onto the processes that initiate cancer long before clinical disease is diagnosed.

In due course, this promises to reveal new diagnostic markers that can be used to anticipate and prevent cancer.

Phys Org, 3 October 2022

https://phys.org

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Extinct animal was just hiding under a rock

2022-10-05

Beneath a single tree on an island 500 kilometres from Port Macquarie, an insect previously thought extinct has been uncovered—quite literally—by a biology student from Sydney University.

When Maxim Adams lifted a rock beneath a banyan tree on Lord Howe Island's northernmost coastline, he was not expecting to find a long-missing animal.

And when he saw an intrusion of large, wingless cockroaches swarming where the rock had been, it took him a moment to realise the significance of what he was seeing.

"I lifted the first rock under this huge banyan tree, and there it was. For the first 10 seconds or so, I thought 'No, it can't be'," Adams says.

'It' is Panesthia lata – or the Lord Howe Island wood-eating cockroach – a species thought to have been wiped out by the arrival of rats on the island in the 1910s.

Adams and his supervising professor Nathan Lo proceeded to spend a week searching for more colonies of these previously vanished arthropods, but to no avail, this was the only group found.

Still, it's a coup, and although Lo recently wrote of the perseverance of related cockroaches on neighbouring islands, the specimens uncovered by Adams are genetically distinct.

The rediscovery and genomic analysis of P. lata further highlights how physical isolation can lead to evolutionary divergence.

"These cockroaches are almost like our very own version of Darwin's finches, separated on little islands over thousands or millions of years developing their own unique genetics," says chair of the Lord Howe Island board, Atticus Fleming.

"The survival is great news, as it has been more than 80 years since it was last seen. Lord Howe Island really is a spectacular place, it's older than the Galápagos islands and is home to 1,600 native invertebrate species, half of which are found nowhere else in the world."

What's in a name?

Scientists find long-lost insect after an 80-year absence.

There are 11 described species of the genus Panesthia, most of which reside along Australia's east coast, feeding on rotten wood that is broken down by specialised cellulose-eating enzymes in their digestive system.

After re-discovering P. lata in July, Lo's team will now turn its focus towards studying the species' habitat, behaviours and genetics.

They also expect to conduct further studies on Lord Howe Island to better understand how the group found beneath the Banyan tree was able to survive.

However the researchers believe that a new name might be needed for this species, with early observations suggesting that rather than living inside rotting logs, the species may actually favour rocks like the one they were found beneath.

"We found families of them, all under this one banyan," says Senior Scientist Nicholas Carlile from NSW's Department of Planning and Environment.

"But despite its common name suggesting they are wood-feeding cockroaches and that they burrow in rotting logs, we now believe they are more of a 'rock-roach', with rocks forming an important component of their habitat, possibly due to their co-evolution alongside the ground foraging Lord Howe Island Woodhen."

Cosmos, 5 October 2022

https://cosmosmagazine.com

Laughing gas found in space could mean life

2022-10-04

Scientists at UC Riverside are suggesting something is missing from the typical roster of chemicals that astrobiologists use to search for life on planets around other stars—laughing gas.

Chemical compounds in a planet's atmosphere that could indicate life, called biosignatures, typically include gases found in abundance in Earth's atmosphere today.

"There's been a lot of thought put into oxygen and methane as biosignatures. Fewer researchers have seriously considered nitrous oxide, but we think that may be a mistake," said Eddie Schwieterman, an astrobiologist in UCR's Department of Earth and Planetary Sciences.

Microorganisms are constantly transforming other nitrogen compounds into N2O, a metabolic process that can yield useful cellular energy.

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This conclusion, and the modeling work that led to it, are detailed in an article published today in The Astrophysical Journal.

To reach it, Schwieterman led a team of researchers that determined how much nitrous oxide living things on a planet similar to Earth could possibly produce. They then made models simulating that planet around different kinds of stars and determined amounts of N2O that could be detected by an observatory like the James Webb Space Telescope.

"In a star system like TRAPPIST-1, the nearest and best system to observe the atmospheres of rocky planets, you could potentially detect nitrous oxide at levels comparable to CO2 or methane," Schwieterman said.

There are multiple ways that living things can create nitrous oxide, or N2O. Microorganisms are constantly transforming other nitrogen compounds into N2O, a metabolic process that can yield useful cellular energy.

"Life generates nitrogen waste products that are converted by some microorganisms into nitrates. In a fish tank, these nitrates build up, which is why you have to change the water," Schwieterman said.

"However, under the right conditions in the ocean, certain bacteria can convert those nitrates into N2O," Schwieterman explained. "The gas then leaks into the atmosphere."

Under certain circumstances, N2O could be detected in an atmosphere and still not indicate life. Schwieterman's team accounted for this in their modeling. A small amount of nitrous oxide is created by lightning, for example. But alongside N2O, lightning also creates nitrogen dioxide, which would offer astrobiologists a clue that non-living weather or geological processes created the gas.

Others who have considered N2O as a biosignature gas often conclude it would be difficult to detect from so far away. Schwieterman explained that this conclusion is based on N2O concentrations in Earth's atmosphere today. Because there isn't a lot of it on this planet, which is teeming with life, some believe it would also be hard to detect elsewhere.

"This conclusion doesn't account for periods in Earth's history where ocean conditions would have allowed for much greater biological release of N2O. Conditions in those periods might mirror where an exoplanet is today," Schwieterman said.

Schwieterman added that common stars like K and M dwarfs produce a light spectrum that is less effective at breaking up the N2O molecule

than our sun is. These two effects combined could greatly increase the predicted amount of this biosignature gas on an inhabited world.

The research team included UCR astrobiologists Daria Pidhorodetska, Andy Ridgwell, and Timothy Lyons, as well as scientists from Purdue University, the Georgia Institute of Technology, American University, and the NASA Goddard Space Flight Center.

The research team believes now is the time for astrobiologists to consider alternative biosignature gases like N2O because the James Webb telescope may soon be sending information about the atmospheres of rocky, Earth-like planets in the TRAPPIST-1 system.

"We wanted to put this idea forward to show it's not out of the question we'd find this biosignature gas, if we look for it," Schwieterman said.

Phys Org, 4 October 2022

https://phys.org

Wax worm saliva shown to degrade plastic bags in just hours

2022-10-04

The search for new solutions to the growing problem of plastic pollution has led scientists to some interesting places that include the soils of a Japanese recycling center and the guts of superworms. These efforts have unearthed enzymes that can eat away plastic materials with high efficiency, and scientists in Spain have just discovered more in the saliva of wax worms, which have the ability to degrade plastic bags in hours at room temperature.

The discovery of these enzymes stems from the work of Federica Bertocchini, a biology researcher and beekeeper in Spain who stumbled upon a peculiar ability of wax worms in 2017. These parasites feed on beeswax and, in an effort to shield her hives from destruction, Bertocchini placed plastic bags over them as protection.

Within 40 minutes, the bags were riddled with holes. Plastic bags are made of polyethylene, which accounts for around 29 percent of the world's plastic consumption and is notoriously difficult to break down. That the worms took around 12 hours to turn the material into a gaping mess presenting some interesting possibilities, with follow-up experiments showing that the worms were actually digesting the plastic, rather than simply chewing through it.

The discovery of these enzymes stems from the work of Federica Bertocchini, a biology researcher and beekeeper in Spain who stumbled upon a peculiar ability of wax worms in 2017.

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But questions remained over how exactly this process was taking place, with the scientists looking to identify the mechanisms behind the worms' ability to devour plastic. Which brings us to new research published this week that was led by Bertocchini and her team at the Biological Research Centre in Madrid.

The scientists used electron microscopy to analyze the saliva of the wax worms, and traced their appetite for plastic to a pair of enzymes. Within a few hours at room temperature, these enzymes worked together to create visible craters on the surface of the plastic and simultaneously oxidize the material. By working in tandem in this manner, the team sees the enzyme pair as a new weapon against plastic degradation, and one that has clear strengths over other enzymes with similar abilities.

"For plastic to degrade, oxygen must penetrate the polymer (the plastic molecule)," explained Bertocchini. "This is the first step in oxidation, which is usually a result of exposure to sunlight or high temperatures, and represents a bottleneck that slows down the degradation of plastics like polyethylene, one of the most resistant polymers. That is why, under normal environmental conditions, plastic takes months or even years to degrade. These enzymes that have been now discovered are the first and only known enzymes capable of degrading polyethylene plastic by oxidizing and breaking down the polymer very rapidly (after just a few hours of exposure) without requiring pre-treatment and work at room temperature."

The scientists hope to carry out further work uncovering the mechanisms behind the enzymes' ability to degrade plastics. They note there is much more work to be done, but hope the technology can one day help tackle to mounting problem of plastic contamination.

New Atlas, 4 October 2022

https://newatlas.com

Engineers create molten salt micro-nuclear reactor to produce nuclear energy more safely

2022-10-05

A nuclear power plant produces 8000 times more power than fossil fuels and is environmentally friendly, but when accidents do occur, they have major repercussions, such as the 1986 Chernobyl disaster. Nearly 100 people died either in the accident or through radiation sickness in the years following.

"Nuclear energy can be extremely safe and extremely affordable, if done the right way."

BYU professor and nuclear engineering expert Matthew Memmott and his colleagues have designed a new system for safer nuclear energy production: a molten salt micro-nuclear reactor that may solve all of these problems and more.

The standard nuclear reactor used in America is the Light-Water Reactor. Uranium atoms are split to create energy, and the products left over will radiate massive amounts of heat. They are kept in solid fuel rods, and water is run through the rods to keep everything cool enough. If there is not enough of a flow of cooling water, the rods can overheat, and the entire facility is at risk for a nuclear meltdown. Memmott's solution is to store these radioactive elements in molten salt instead of fuel rods.

"Nuclear energy can be extremely safe and extremely affordable, if done the right way," Memmott said. "It's a very good solution to the energy situation we're in because there are no emissions or pollution from it."

In Memmott's new reactor, during and after the nuclear reaction occurs, all the radioactive byproducts are dissolved into molten salt. Nuclear elements can emit heat or radioactivity for hundreds of thousands of years while they slowly cool, which is why nuclear waste is so dangerous (and why in the past, finding a place to dispose of it has been so difficult). However, salt has an extremely high melting temperature—550°C—and it doesn't take long for the temperature of these elements in the salt to fall beneath the melting point. Once the salt crystalizes, the radiated heat will be absorbed into the salt (which doesn't remelt), negating the danger of a nuclear meltdown at a power plant.

Another benefit of the molten salt nuclear reactor design is that it has the potential to eliminate dangerous nuclear waste. The products of the reaction are safely contained within the salt, with no need to store them elsewhere. What's more, many of these products are valuable, and can be can be removed from the salt and sold.

Molybdenum-99, for example, is an extremely expensive element used in medical imaging procedures and scans that can be extracted. The United States currently buys all of its Molybdenum-99 from the Netherlands, but with this reactor it can easily be made within the country, making it much more accessible and affordable. Cobalt-60, gold, platinum, neodymium, and many other elements can also be taken out of the salt, resulting in potentially no nuclear waste.

"As we pulled out valuable elements, we found we could also remove oxygen and hydrogen," Memmott said. "Through this process, we can

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make the salt fully clean again and reuse it. We can recycle the salt indefinitely."

A typical nuclear power plant is built with a little over one square mile to operate to reduce radiation risk, with the core itself being 30 ft x 30 ft. Memmott's molten salt nuclear reactor is 4 ft x 7ft, and because there is no risk of a meltdown there is no need for a similar large zone surrounding it. This small reactor can produce enough energy to power 1000 American homes. The research team said everything needed to run this reactor is designed to fit onto a 40-foot truck bed; meaning this reactor can make power accessible to even very remote places.

Others who helped with this project are BYU professors Troy Munro, Stella Nickerson, John Harb, Yuri Hovanski, Ben Frandsen, and BYU graduate student Andrew Larsen.

Memmott uses the analogy of a silicon chip to compare the abilities of this new reactor with the old one. When computers were first invented it took a giant vacuum tube controlling electron flow and an entire room to run a very limited, very simple computer. We no longer use that technology though because someone invented a silicon chip, which allowed technology to advance to the tiny and efficient devices we have today. The silicon chip fixed the issues with the early computers, and this molten salt reactor can fix the issues with the current nuclear reactor.

"For the last 60 years, people have had the gut reaction that nuclear is bad, it's big, it's dangerous," Memmott said. "Those perceptions are based on potential issues for generation one, but having the molten salt reactor is the equivalent of having a silicon chip. We can have smaller, safer, cheaper reactors and get rid of those problems."

Tech Xplore, 5 October 2022

https://techxplore.com

A Better Way To Grow Meat in the Lab: Zapping Cells With a Magnet

2022-10-06

By zapping animal cells with a magnet, researchers from the National University of Singapore (NUS) have discovered a revolutionary method of producing cell-based meat. By using fewer animal products, this innovative method streamlines the production of cell-based meat and makes it safer, cleaner, and more cost-effective.

The new process is a more environmentally friendly, cleaner, safer, and cost-effective way to make cell-based meat.

The benefits of cultured meat over traditional animal agriculture include a reduced carbon footprint and a lower chance of animal disease transmission. However, the current method of producing cultured meat needs the use of other animal products, which largely defeats the purpose, or drugs to stimulate the meat's growth.

Animal cells are given animal serum – typically fetal bovine serum (FBS), which is a combination obtained from the blood of fetuses excised from pregnant cows killed in the dairy or meat industries – to help them develop and proliferate in order to cultivate cell-based meat. This is an important, though cruel and costly, stage in the current cell-based meat manufacturing process. Many of these molecules, ironically, come from the muscles of the slain animal, but scientists had no idea how to stimulate their release in large-scale bioreactors. Other methods for promoting cell proliferation include the use of drugs or genetic engineering.

The complex manufacturing method for cell-based meat raises costs, restricts manufacturing scale, and threatens commercial viability.

To help address this challenge, a multidisciplinary research team led by Associate Professor Alfredo Franco-Obregón, who is from the NUS Institute for Health Innovation & Technology and the NUS Yong Loo Lin School of Medicine, came up with an unconventional method of using magnetic pulses to stimulate the growth of cell-based meat.

Growing cell-based meat with the help of a magnet

The NUS technique uses a delicately tuned pulsed magnetic field developed by the team to culture myogenic stem cells, which are found in skeletal muscle and bone marrow tissue.

Assoc Prof Franco-Obregón explained, "In response to a short 10-minute exposure to the magnetic fields, the cells release a myriad of molecules that have regenerative, metabolic, anti-inflammatory, and immunity-boosting properties. These substances are part of what is known as the muscle "secretome" (for secreted factors) and are necessary for the growth, survival, and development of cells into tissues. We are very excited about the possibility that magnetically-stimulated secretome release may one day replace the need for FBS in the production of cultured meat."

He added, "The growth-inducing secretomes can be harvested in the lab safely and conveniently, and also at low cost. This way, the myogenic stem cells will act as a sustainable and green bioreactor to produce the nutrient-rich secretomes for growing cell-based meat at scale for consumption.

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The muscle knows how to produce what it needs to grow and develop – it simply needs a little bit of encouragement when it is outside its owner. This is what our magnetic fields can provide."

Applications in regenerative medicine

The harvested secretomes can also be used for regenerative medicine. The NUS team used the secreted proteins to treat unhealthy cells and found that they help to accelerate the recovery and growth of unhealthy cells. Therefore, this method can potentially help to cure injured cells and speed up a patient's recovery.

Sci Tech Daily, 6 October 2022

https://scitechdaily.com

Dinosaur-killing asteroid triggered global tsunami that scoured seafloor thousands of miles from impact site

2022-10-04

The miles-wide asteroid that struck Earth 66 million years ago wiped out nearly all the dinosaurs and roughly three-quarters of the planet's plant and animal species.

It also triggered a monstrous tsunami with mile-high waves that scoured the ocean floor thousands of miles from the impact site on Mexico's Yucatan Peninsula, according to a new University of Michigan-led study.

The study, scheduled for online publication Oct. 4 in the journal AGU Advances, presents the first global simulation of the Chicxulub impact tsunami to be published in a peer-reviewed scientific journal. In addition, U-M researchers reviewed the geological record at more than 100 sites worldwide and found evidence that supports their models' predictions about the tsunami's path and power.

"This tsunami was strong enough to disturb and erode sediments in ocean basins halfway around the globe, leaving either a gap in the sedimentary records or a jumble of older sediments," said lead author Molly Range, who conducted the modeling study for a master's thesis under U-M physical oceanographer and study co-author Brian Arbic and U-M paleoceanographer and study co-author Ted Moore.

The review of the geological record focused on "boundary sections," marine sediments deposited just before or just after the asteroid impact

The miles-wide asteroid that struck Earth 66 million years ago wiped out nearly all the dinosaurs and roughly three-quarters of the planet's plant and animal species.

and the subsequent K-Pg mass extinction, which closed the Cretaceous Period.

"The distribution of the erosion and hiatuses that we observed in the uppermost Cretaceous marine sediments are consistent with our model results, which gives us more confidence in the model predictions," said Range, who started the project as an undergraduate in Arbic's lab in the Department of Earth and Environmental Sciences.

The study authors calculated that the initial energy in the impact tsunami was up to 30,000 times larger than the energy in the December 2004 Indian Ocean earthquake tsunami, which killed more than 230,000 people and is one of the largest tsunamis in the modern record.

The team's simulations show that the impact tsunami radiated mainly to the east and northeast into the North Atlantic Ocean, and to the southwest through the Central American Seaway (which used to separate North America and South America) into the South Pacific Ocean.

In those basins and in some adjacent areas, underwater current speeds likely exceeded 20 centimeters per second (0.4 mph), a velocity that is strong enough to erode fine-grained sediments on the seafloor.

In contrast, the South Atlantic, the North Pacific, the Indian Ocean and the region that is today the Mediterranean were largely shielded from the strongest effects of the tsunami, according to the team's simulation. In those places, the modeled current speeds were likely less than the 20 cm/sec threshold.

For the review of the geological record, U-M's Moore analyzed published records of 165 marine boundary sections and was able to obtain usable information from 120 of them. Most of the sediments came from cores collected during scientific ocean-drilling projects.

The North Atlantic and South Pacific had the fewest sites with complete, uninterrupted K-Pg boundary sediments. In contrast, the largest number of complete K-Pg boundary sections were found in the South Atlantic, the North Pacific, the Indian Ocean and the Mediterranean.

"We found corroboration in the geological record for the predicted areas of maximal impact in the open ocean," said Arbic, professor of earth and environmental sciences who oversaw the project. "The geological evidence definitely strengthens the paper."

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Of special significance, according to the authors, are outcrops of the K-Pg boundary on the eastern shores of New Zealand's north and south islands, which are more than 12,000 kilometers (7,500 miles) from the Yucatan impact site.

The heavily disturbed and incomplete New Zealand sediments, called olistostromal deposits, were originally thought to be the result of local tectonic activity. But given the age of the deposits and their location directly in the modeled pathway of the Chicxulub impact tsunami, the U-M-led research team suspects a different origin.

"We feel these deposits are recording the effects of the impact tsunami, and this is perhaps the most telling confirmation of the global significance of this event," Range said.

The modeling portion of the study used a two-stage strategy. First, a large computer program called a hydrocode simulated the chaotic first 10 minutes of the event, which included the impact, crater formation and initiation of the tsunami. That work was conducted by co-author Brandon Johnson of Purdue University.

Based on the findings of previous studies, the researchers modeled an asteroid that was 14 kilometers (8.7 miles) in diameter, moving at 12 kilometers per second (27,000 mph). It struck granitic crust overlain by thick sediments and shallow ocean waters, blasting a roughly 100-kilometer-wide (62-mile-wide) crater and ejecting dense clouds of soot and dust into the atmosphere.

Two and a half minutes after the asteroid struck, a curtain of ejected material pushed a wall of water outward from the impact site, briefly forming a 4.5-kilometer-high (2.8-mile-high) wave that subsided as the ejecta fell back to Earth.

Ten minutes after the projectile hit the Yucatan, and 220 kilometers (137 miles) from the point of impact, a 1.5-kilometer-high (0.93-mile-high) tsunami wave -- ring-shaped and outward-propagating -- began sweeping across the ocean in all directions, according to the U-M simulation.

At the 10-minute mark, the results of Johnson's iSALE hydrocode simulations were entered into two tsunami-propagation models, MOM6 and MOST, to track the giant waves across the ocean. MOM6 has been used to model tsunamis in the deep ocean, and NOAA uses the MOST model operationally for tsunami forecasts at its Tsunami Warning Centers.

"The big result here is that two global models with differing formulations gave almost identical results, and the geologic data on complete and incomplete sections are consistent with those results," said Moore, professor emeritus of earth and environmental sciences. "The models and the verification data match nicely."

According to the team's simulation:

- One hour after impact, the tsunami had spread outside the Gulf of Mexico and into the North Atlantic.
- Four hours after impact, the waves had passed through the Central American Seaway and into the Pacific.
- Twenty-four hours after impact, the waves had crossed most of the Pacific from the east and most of the Atlantic from the west and entered the Indian Ocean from both sides.
- By 48 hours after impact, significant tsunami waves had reached most of the world's coastlines.

For the current study, the researchers did not attempt to estimate the extent of coastal flooding caused by the tsunami.

However, their models indicate that open-ocean wave heights in the Gulf of Mexico would have exceeded 100 meters (328 feet), with wave heights of more than 10 meters (32.8 feet) as the tsunami approached North Atlantic coastal regions and parts of South America's Pacific coast.

As the tsunami neared those shorelines and encountered shallow bottom waters, wave heights would have increased dramatically through a process called shoaling. Current speeds would have exceeded the 20 centimeters per second threshold for most coastal areas worldwide.

"Depending on the geometries of the coast and the advancing waves, most coastal regions would be inundated and eroded to some extent," according to the study authors. "Any historically documented tsunamis pale in comparison with such global impact."

A follow-up study is planned to model the extent of coastal inundation worldwide, Arbic said. That study will be led by Vasily Titov of the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Lab, who is a co-author of the AGU Advances paper.

Science Daily, 4 October 2022

https://sciencedaily.com

CHEMWATCH
Bulletin Board
Curiosities
OCT. 14, 2022

Cavity-causing microbe "superorganisms" grow limbs to leap across teeth

2022-10-05

If you needed more motivation to brush your teeth regularly, this could do the trick. Scientists have discovered that cavity-causing bacteria and fungi in saliva can team up to form "superorganisms" that can actually sprout limbs to crawl and even leap across teeth.

The team, led by scientists at the University of Pennsylvania School of Dental Medicine, made the unexpected discovery while studying saliva samples from children with severe tooth decay. They'd noticed that two species were involved in cavity formation – the bacteria Streptococcus mutans and the fungus Candida albicans – and later found that they actually formed clusters together.

These clusters, or assemblages, are made up of communities of bacteria attached to networks of fungal filaments, all glued together with a material known as an extracellular polymer. This made the microbes more resilient than either species on their own, sticking to teeth better and increasing their resistance to antimicrobials.

Curious, the team grew them in a lab on a tooth-like material, incubated in human saliva, and watched them with a microscope that recorded them in real time. And that's when the truly bizarre behavior emerged. Even though neither species can move on its own, these assemblages were able to use their fungal projections to crawl across the tooth surface at speeds of over 40 microns per hour. Weirder still, they could leap more than 100 microns in a single bound, which, relative to body size, is about four times farther than frogs.

"They have a lot of what we call 'emergent functions' that bring new benefits to this assemblage that they could not achieve on their own," said Hyun Koo, co-corresponding author of the study. "It's almost like a new organism – a superorganism – with new functions."

The team says that this newfound mobility helps the microbes colonize teeth more efficiently, and in lab tests on real human teeth, they found more widespread tooth decay followed the growth of these clusters.

Finding ways to block the formation of these assemblages could be an important strategy to prevent childhood tooth decay, the team says.

If you needed more motivation to brush your teeth regularly, this could do the trick.

The research was published in the journal PNAS.

New Atlas, 5 October 2022

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