Ode to E Pluribus Unum for Sunday May 14 2023

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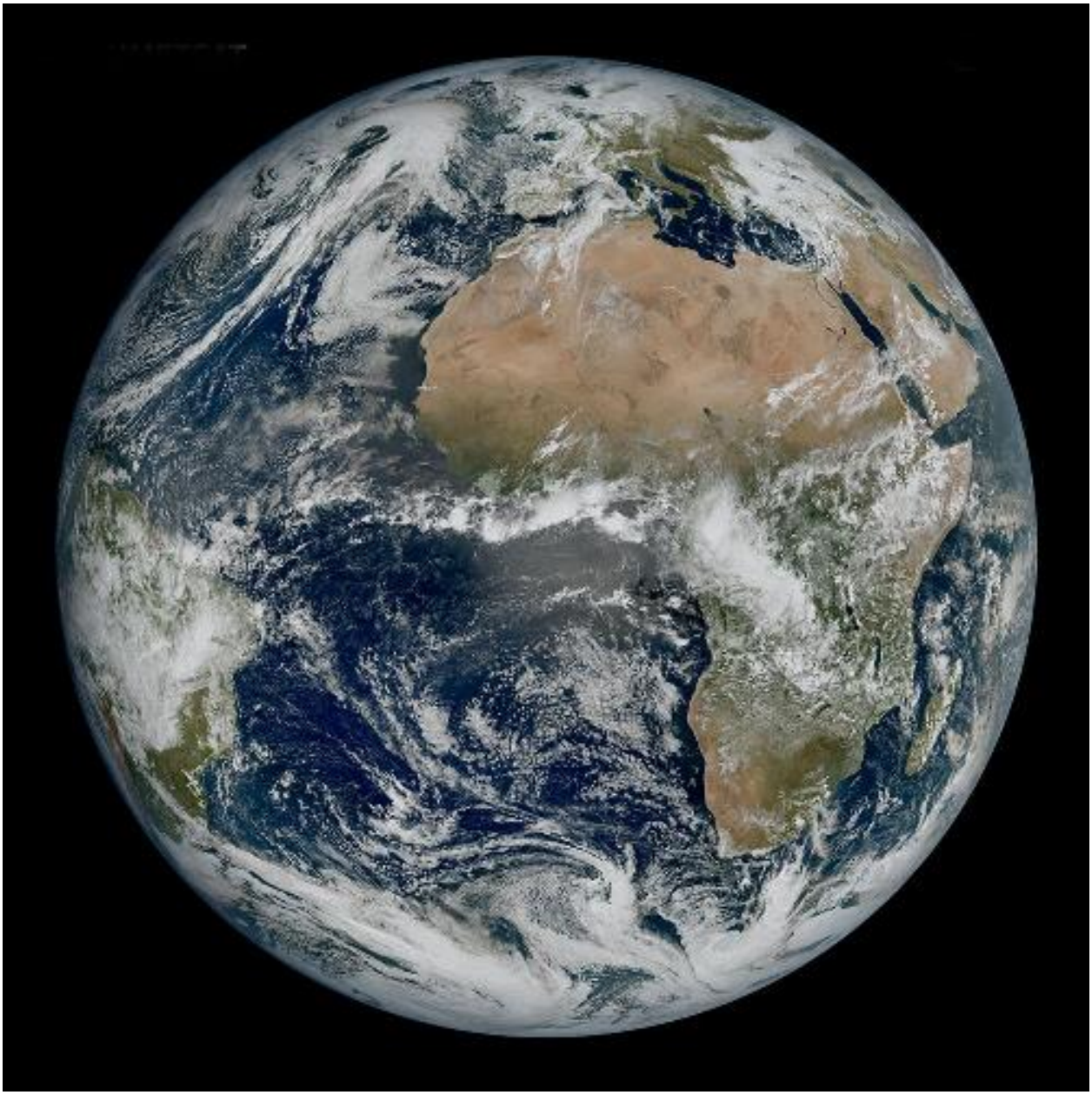
Photo of Earth Taken by Europe’s Powerful New Satellite



Europe's Meteosat Third Generation Imager-1 (MTG-I1) has delivered its first view of Earth revealing the weather conditions above Africa, Europe, and the Atlantic.
ESA

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Bait Ball

On Western Australia's Ningaloo Reef off Exmouth, a bait ball shows the ecosystem's intricate food chain in action.

Photographs by Federico Facchin

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The Deep Sea

Take a voyage to the bottom of the sea to see who and what are there.

Jacques Picard's Trieste
sciencemuseum.org

https://neal.fun/deep-sea/

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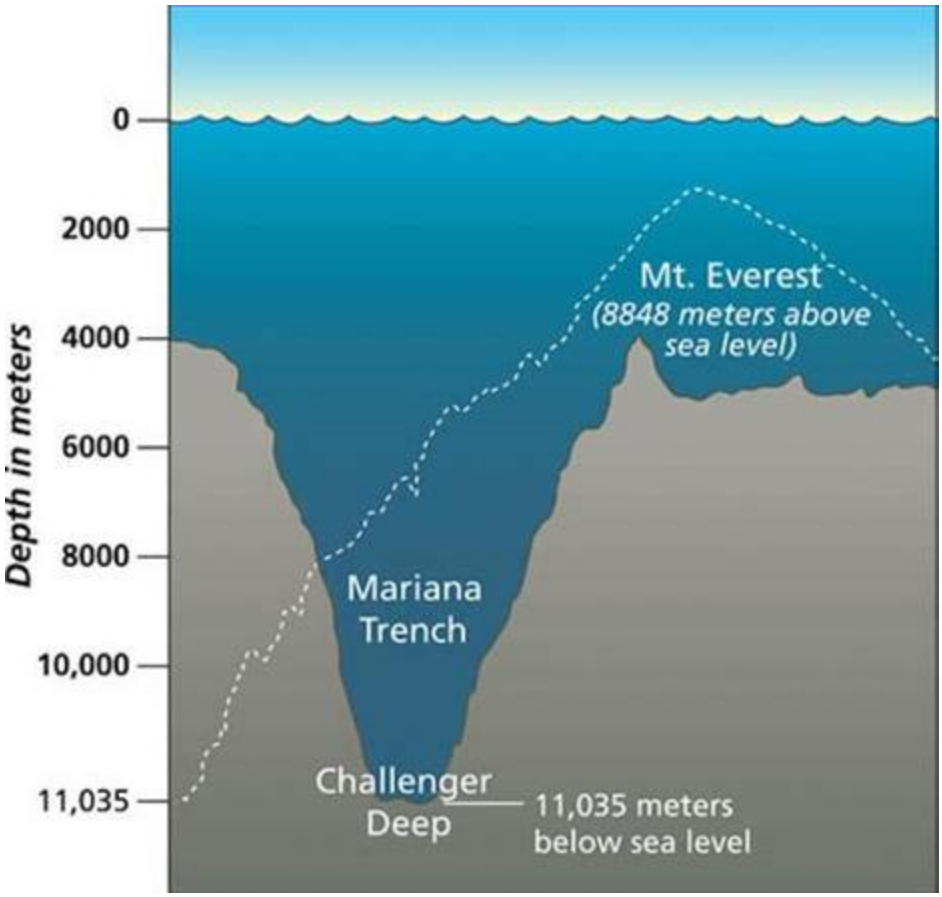
Mariana Trench | In Pursuit of the Abyss



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How Do We Remove CO2 and Where Does It Go?

Carbon dioxide (CO_2) is a greenhouse gas that traps heat and warms the planet. Because of the burning of fossil fuels, the amount of CO_2 in the earth's atmosphere is higher than it has been in at least one million years.

Other gases contribute to climate change, but CO_2 poses the greatest challenge: It accounts for 81 percent of all greenhouse gas emissions and can linger in the atmosphere for thousands of years. Methane, in comparison, has a lifetime of a decade.

Why do we need to remove CO_2?

Nature mitigates carbon and reduces some of the effects of climate change: Plants, trees, and algae in the ocean turn CO_2 into oxygen through photosynthesis, and the ocean absorbs and stores CO_2 in ocean sinks. But nature cannot withstand the rising levels of human-produced emissions. Consequently, Earth and the people on it have experienced the effects of climate change, such as more frequent and intense weather events.

That is why, in addition to efforts that reduce emissions through decreased fossil fuel use, scientists, engineers, and policy makers are pursuing techniques to decrease the CO_2 that reaches and stays in the atmosphere and oceans.

Currently, 40 million tons of CO_2 are captured from power and industrial facilities each year. But the International Energy Association estimates that number needs increase by more than 100 times to meet the United Nations' energy-related sustainable development goals. Some scientists believe implementing these techniques may be more feasible than decarbonizing certain industries, such as long-distance transportation and the airline industry.

Methods of removing and storing carbon

Carbon capture, utilization, and storage (CCUS) involves collecting CO_2 from emission sources such as coal-burning power plants and converting it to other products, storing it, or burying it. Ocean-based solutions, such as ocean alkalinity enhancement, increase the ocean's natural ability to remove and store CO_2. Direct air capture physically and chemically pulls existing CO_2 from the atmosphere and returns it to the ecosystem in less harmful forms, such as oxygen or low-carbon synthetic fuel.

Policy makers attempt to reduce CO_2 emissions by promoting carbon offsets, which allow companies to compensate for the CO_2 they emit by paying another entity to remove carbon elsewhere.

Methods to capture, sequester, and pull CO_2 are gaining traction today partly because of the Paris Climate Agreement, which calls for limiting the jump in Earth's average global surface temperatures to no more than 2 degrees Celsius by 2050.

Examples of current carbon removal approaches:

Carbon farming is a set of practices, such as leaving crop residues in the field, that increase the amount of CO_2 crops capture and store in soil. Carbon farming has been shown to result in healthier soil and increased crop yields as well. Recommended practices and climate-mitigation potential vary by location and should be based on experimental data.

Direct air capture stations use large, powerful fans to draw in existing carbon emissions from the atmosphere. Once inside a capture station, the air undergoes a series of chemical reactions that cause CO_2 to separate from the rest of the air. The concentrated CO_2 can then be stored underground, sold to beverage companies that need carbonation for their drinks, or converted into synthetic fuel. (Although burning synthetic fuel rereleases CO_2 into the atmosphere, this use could still provide benefits by replacing fossil fuel.) As of 2020, there were 15 direct air capture stations throughout the world and together, they scrubbed 9,000 tons of CO_2 a year, far less than other techniques that remove CO_2 at the gigaton scale. In 2021, the world's largest direct air capture station opened in Iceland.

Reforestation (reestablishing forests) and afforestation (creating new forests) are popular and low-technology approaches for carbon capture and removal. The addition of 2.2 billion more acres of forest could store a total of 205 gigatons of CO_2, according to a 2019 report published in Science.

Examples of other new and emerging strategies for removing CO_2:

Accelerated limestone weathering builds on a natural form of carbon sequestration in which compounds in calcium carbonate (found in shells on the ocean floor), seawater, and CO_2 break down and turn into dissolved bicarbonate ions. The process usually takes tens of thousands of years, but researchers identified an enzyme that can make the reaction 500 times faster. In addition, USC and Caltech scientists, including Resnick Sustainability Institute researcher Jess Adkins are creating a prototype treatment tank for cargo ships that could one day transform flue gas into slightly saltier water that can be returned to the ocean. Instead of shells, the treatment tank uses limestone rocks, which are made of calcium carbonate, to ignite the chemical reaction.

Geological sequestration proposes to capture carbon emissions at their source, such as at a power plant, then pressurize CO_2 until it changes into a liquid. This method builds on a technique oil companies use to revive production in older wells. The carbon would then travel through a pipeline deep into Earth, where it would be stored under geological formations to seep into the pores of rocks or to mineralize into new rock. Researchers, such as Anima Anandkumar, Caltech's Bren Professor of Computing and Mathematical Sciences, are using AI tools to determine the best places to inject carbon for safe and effective storage.

Solar fuels leverage the sun's abundant energy to create clean liquid fuel. Through their work on the Liquid Sunlight Alliance (and its predecessor, the Joint Center for Artificial Photosynthesis), researchers from Caltech and partner institutions have refined an artificial photosynthesis process that uses sunlight to split water into hydrogen and oxygen. They are now attempting to combine the separated hydrogen with carbon emitted from fossil fuel burning to power cars, homes, and factories.

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Air Pollution Levels Around the World in 2022

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NASA-Led Project Tracking Changes to Water, Ecosystems, Land

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Taking Notes vs. Photographing Slides

A picture isn't always worth a thousand words.

New research shows that taking notes helps you to remember more from lectures than photographing slides.

New research has found that students who take notes outperform students who photograph slides during an online lecture.

Dr. Sarah Shi Hui Wong, an instructor at the National University of Singapore, and the lead author of the paper describes the research on taking notes(opens in new tab), explains how the study was conducted, what inspired it, and how she discusses the research with her students.

What Inspired Research on Taking Notes?

"In recent years, we've seen many students whipping out their smartphones to take photos of lecture materials," Wong says. "As educators, we've sometimes found ourselves suddenly becoming unwitting celebrities faced with a sea of cameras in lectures."

Technology has equipped students with more note-taking tools for quickly and conveniently recording information, however, she says, "What's less clear is how these newer methods actually fare against traditional ones such as longhand note-taking."

Wong and her colleagues wanted to determine whether students learn better by writing notes, taking photos, or not taking any notes or photos at all, a surprisingly understudied area.

How Was The Research Conducted?

Two hundred college students were recruited as part of two experiments. In both, students were presented with a series of video-recorded lectures and were randomly assigned to either write notes, take photos using their smartphone camera, or not take any notes or photos.

"The lectures comprised PowerPoint slides with audio narration, much like how many online lessons are delivered," Wong says. "Before the lectures, we told all students that they would later be tested on the material. All students were also informed of and provided with a review opportunity before the test. This was important because

students often take notes or photos precisely so they can revisit them later when preparing for an exam."

After watching the lecture, note-takers reviewed their handwritten notes, photo-takers reviewed their photos, and students who didn't take notes were given exact printouts of the lecture slides to review.

"Since photos and printouts would only contain information that had been visually presented on the slides, we ensured that the audio narration in the lectures overlapped closely with the onscreen content, so that photo-takers and no-note-takers wouldn't be unfairly disadvantaged," Wong says. "After the review opportunity, the students were tested on their recall of the lecture content by typing as much as they could remember. This typing procedure ensured that all students did the test using a medium that was different from what they had used during the lectures. Otherwise, a pen-and-paper test may unfairly favor note-takers who had similarly studied the lectures by writing notes."

What The Research Found

"Across both experiments, we consistently found that note-takers remembered more information from the lectures than photo-takers or no-note-takers," Wong says. "In fact, photo-takers performed just as poorly on the test as their peers who didn't take any notes at all."

Wong adds, "The longhand advantage occurred even though note-takers only managed to write down about 50% of the lecture content in their notes, whereas photo-takers and no-note-takers could access up to 100% of the lecture content in their photos or printouts during review."

In the second experiment, Wong and her colleagues also looked at mind-wondering in the note-takers vs. other groups.

"We found that photo-takers and no-note-takers reported mind-wandering more frequently during the lectures than note-takers, and this attentional difference predicted the students' later test performance," Wong says. "Put together, our results show that writing notes reduces mind-wandering more than photo-taking or no-note-taking. In turn, this attentional advantage improves students' learning and memory of lecture content."

What Wong Tells Her Students About the Research

"In my classes, I now share this study with my students and we discuss how they can apply the findings to their learning," Wong says. "I encourage my students to take notes and put aside their smartphone – camera – during class. In my experience, discussing the science of learning with students through such research also piques their

interest and curiosity in questioning what kinds of study methods are more effective and why."

Other Questions and Potential Causes

Wong's study did not compare longhand note-taking to typed note-taking on a laptop. That question has been researched in the past and the results are mixed.

"An early study found that longhand note-taking yields better test performance than laptop note-taking(opens in new tab), but some recent replications(opens in new tab) have not found definitive evidence for this effect," she says.

In addition, there is still more to learn about exactly why note-taking seems so beneficial to learning. "Other studies have shown that students learn better when they engage in generative processes such as summarizing, organizing, and integrating information during note-taking," Wong says. "These generative processes enable students to learn the material deeply and meaningfully, and are not mutually exclusive with the role of mind-wandering."

The quality of students' notes also matters. "If students take notes by simply transcribing their teacher's words verbatim instead of engaging in generative processes, then they are less likely to learn deeply," says Wong. "Rather, it's important to guide students on how to take high-quality notes for their effective learning."

By Erik Ofgang for Tech & Learning

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Why the Brain's Connections to the Body Are Crisscrossed

In all bilaterally symmetrical animals, from humans down to simple worms, nerves cross from one side of the body to the opposite side of the brain. Geometry may explain why.

James O'Brien for Quanta Magazine

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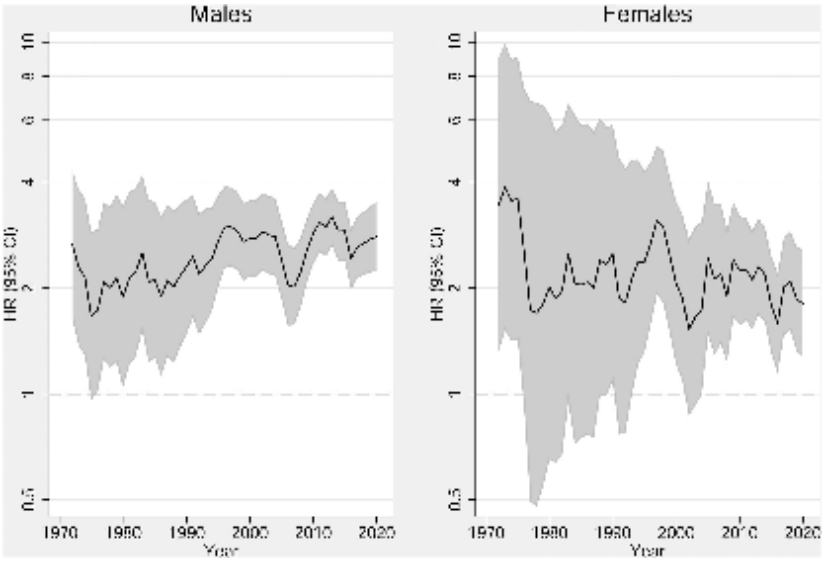
Young Men At Highest Risk of Schizophrenia Linked With Cannabis Use Disorder



Researchers found strong evidence of an association between cannabis use disorder and schizophrenia among men and women, though the association was much stronger among young men. Using statistical models, the study authors estimated that as many as 30% of cases of schizophrenia among men aged 21-30 might have been prevented by averting cannabis use disorder.

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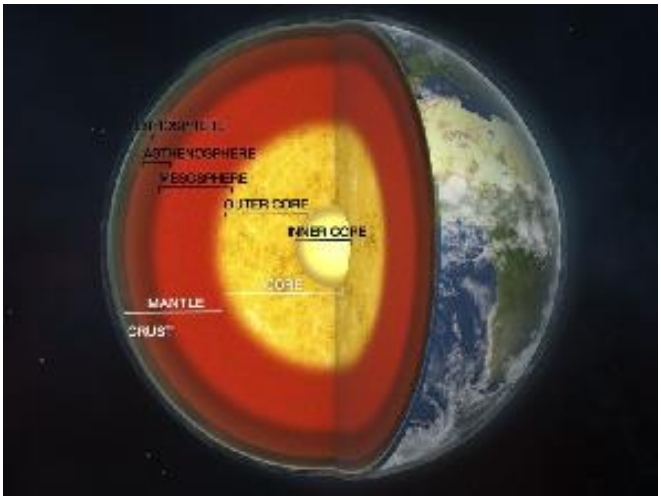
How Did Earth's Continents Form?

Leading theory may be in doubt.



A cross section of Earth showing the various layers that make up the planet.
(Image credit: Science Photo Library/Getty Images)

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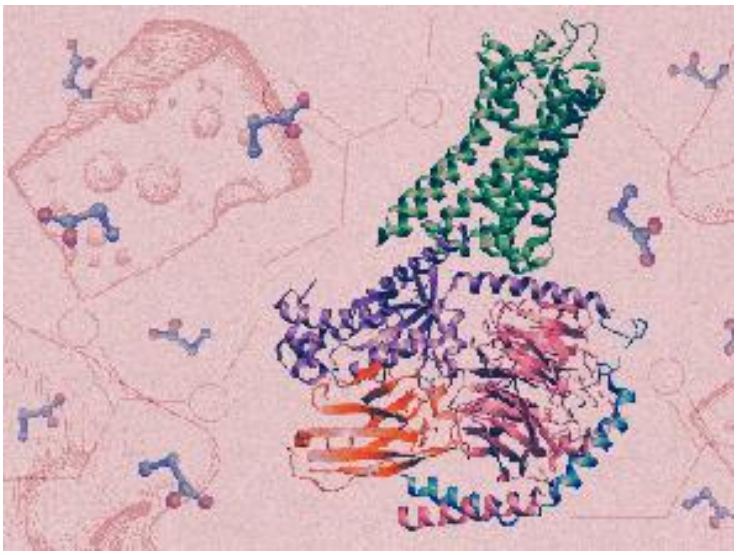
How a Human Smell Receptor Works Is Finally Revealed

After decades of frustration, researchers have determined how an airborne scent molecule links to a human smell receptor.



Researcher recently identified how a type of olfactory receptor protein (at center) in the human nose detects airborne molecules of propionate, a component of the smell of Swiss cheese.
Kristina Armitage/Quanta Magazine; Sources: NIH/NIDCD; ArtBalitskiy/iStock; Alhontess/iStock

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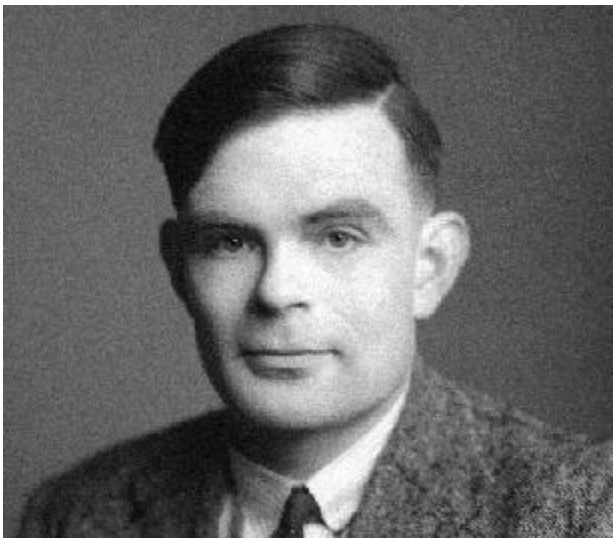
The Most Important Machine That Was Never Built

When he invented Turing machines in 1936, Alan Turing also invented modern computing.



Alan Turing helped define computation, algorithms and what came to be known as the Turing machine.
GLArchive/Alamy

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Eli Lilly Says New Drug Slows Early Stages of Alzheimer's By 35%

PharmaTimes Online

Donanemab, an Alzheimer's drug developed by Eli Lilly slowed cognitive and functional decline for people with early stages of the disease, a study that could lead to a new commercially available drug for the mind-robbing disease, the drug company said Wednesday.

https://youtu.be/U4QaJ2XWB8s?t=1

Lilly said people on the experimental drug donanemab slowed decline by 35% compared to a placebo group based on a measure of daily activities such as driving, managing finances and talking about current events.

Lilly said it will submit an application by the end of June to the Food and Drug Administration seeking approval to market the amyloid plaque-busting drug.

"We hope that this is an exciting day for patients and their families," said Dawn Brooks, Lilly's global development leader for donanemab.

In January, the FDA rejected Lilly's attempt to get accelerated approval for donanemab because the agency said the midstage study did not include enough people over at least 12 months.

If the new late-stage study that enrolled more than 1,700 people is enough to warrant FDA approval, it would be the third amyloid-targeting Alzheimer's drug to gain approval.

In January, Eisai and Biogen received FDA approval to sell Leqembi for patients in the early stages of Alzheimer's disease. In 2021, Biogen's Aduhelm was the first to gain

approval based on studies that delivered mixed results – an approval that prompted investigations from two U.S. House committees.

What did Lilly's new donanemab study find?

The Trailblazer 2 study found the drug slowed decline by 35% compared to the placebo based on the integrated Alzheimer's disease rating scale, which measures cognition and daily living activities.

Lilly also reported 47% of study participants on donanemab had no decline compared to 29% on placebo. Lilly said 52% completed their donanemab treatment within a year and 72% within 18 months.

Brooks said participants on the drug were allowed to switch to the placebo if the drug cleared all amyloid plaque before the end of the trial.

"Over half of the participants in the donanemab treatment (group) were able to complete the course of treatment in 12 months," Brooks said.

What were the side effects?

Drugs that target and clear amyloid can cause swelling or small bleeds in the brain. These are known as amyloid-related imaging abnormalities, or ARIA, detected by an MRI scan that patients must undergo.

Lilly said 24% of people on the drug had signs of brain swelling, known as ARIA-E, though most did not notice any symptoms. Tiny brain bleeds, known as ARIA-H, were detected in just over 31% on the drug compared to nearly 14% in the placebo group.

Two participants died as a result of ARIA, and a third person died after experiencing ARIA.

What's next for Alzheimer's drugs?

Donanemab, Leqembi and Aduhelm are part of a pipeline of treatments based on a decades-old theory that Alzheimer's disease is triggered by amyloid that accumulates in patients' brains and can be slowed by drugs that remove the buildup of this protein.

Both Leqembi and Biogen's Aduhelm received accelerated approval to get the drugs to market. The Aduhelm approval was controversial and prompted a probe from two U.S. House committees that found the FDA sidestepped outside experts who said trials failed to prove the clinical benefit of the drug.

Following Aduhelm's approval, the Centers for Medicare and Medicaid Services said it would pay for such drugs that received FDA accelerated approval only in clinical trials.

With more than 6 million Americans afflicted with the memory-scuttling disease, advocates are pushing centers to pay for these new drug treatments outside of clinical trials.

Maria Carrillo, Alzheimer's Association chief science officer, said the latest donanebab results are "the strongest Phase 3 data for an Alzheimer's treatment to date."

"The progress we've seen in this class of treatments, as well as the diversification of potential new therapies over the past few years, provides hope to those impacted by this devastating disease," she said. "Yet, Medicare stubbornly continues to block access for the people who could benefit."

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NASA's Photographer of the Year Awards

https://bit.ly/424luzj

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This Week's Aaron Copeland

Lincoln Kirstein and Eugene Loring of Ballet Caravan asked Copland to compose music for a cowboy ballet.

"Lincoln tempted me with several books of western tunes, and Loring wrote a scenario about the notorious bandit of the Southwest, Billy the Kid. I became intrigued with using tunes such as Git Along Little Dogies, The Old Chisholm Trail, and Goodbye Old Paint."

The ballet is still performed regularly, and the orchestral suite of six connecting movements is one of Copland's most popular works.

- 1. The Open Prairie
- 2. Street in a Frontier Town
- 3. Card Game at Night
- 4. Gun Battle
- 5. Celebration After Billy's Capture
- 6. Billy's Demise
- 7. The Open Prairie (epilogue)

Billy the Kid Concert Suite https://bit.ly/42huYYu

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The Secret Life of Urban Crows

…and why Seattle may be the Corvid[1] Capital of the World.

Kaeli Swift employs taxidermic specimens to study how crows process the death of one of their own.
Image: Mike Kane

https://bit.ly/41UwmQ2

[1]Member of the bird family Corvidae, including crows, ravens, jays, choughs, treepies etc.

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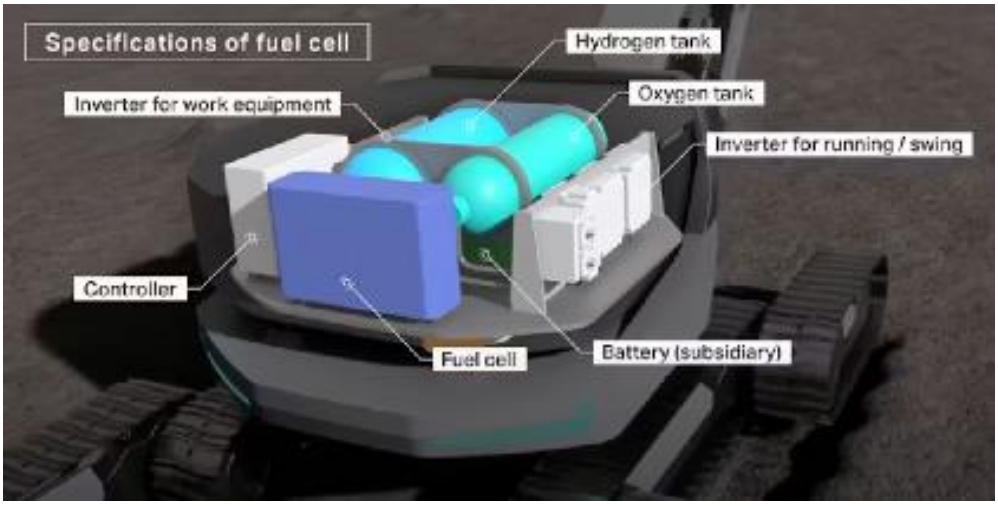
Komatsu Simulation Shows Lunar Excavator at Work

Komatsu is running simulations of its lunar construction excavator, and a video posted by the company explains how it might work.



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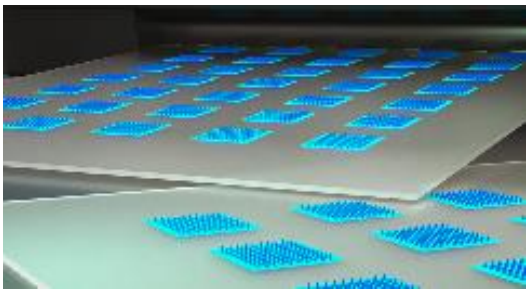
Vaccine Printer Could Help Vaccines Reach More People

The printer generates vaccine-filled microneedle patches that can be stored long-term at room temperature and applied to the skin.



Getting vaccines to people who need them isn't always easy. Many vaccines require cold storage, making it difficult to ship them to remote areas that don't have the necessary infrastructure.

MIT researchers have come up with a possible solution to this problem: a mobile vaccine printer that could be scaled up to produce hundreds of vaccine doses in a day. This kind of printer, which can fit on a tabletop, could be deployed anywhere vaccines are needed, the researchers say.

"We could someday have on-demand vaccine production," says Ana Jaklenec, a research scientist at MIT's Koch Institute for Integrative Cancer Research. "If, for example, there was an Ebola outbreak in a particular region, one could ship a few of these printers there and vaccinate the people in that location."

The printer produces patches with hundreds of microneedles containing vaccine. The patch can be attached to the skin, allowing the vaccine to dissolve without the need for a traditional injection. Once printed, the vaccine patches can be stored for months at room temperature.

In a study appearing today in Nature Biotechnology, the researchers showed they could use the printer to produce thermostable Covid-19 RNA vaccines that could induce a comparable immune response to that generated by injected RNA vaccines, in mice.

Jaklenec and Robert Langer, the David H. Koch Institute Professor at MIT and a member of the Koch Institute, are the senior authors of the study. The paper's lead authors are former MIT postdoc Aurelien vander Straeten, Morteza Sarmadi PhD '22, and postdoc John Daristotle.

Printing vaccines

Most vaccines, including mRNA vaccines, must be refrigerated while stored, making it difficult to stockpile them or send them to locations where those temperatures can't be maintained. Furthermore, they require syringes, needles, and trained health care professionals to administer them.

To get around this obstacle, the MIT team set out to find a way to produce vaccines on demand. Their original motivation, before Covid-19 arrived, was to build a device that could quickly produce and deploy vaccines during outbreaks of diseases such as Ebola. Such a device could be shipped to a remote village, a refugee camp, or military base to enable rapid vaccination of large numbers of people.

Instead of producing traditional injectable vaccines, the researchers decided to work with a novel type of vaccine delivery based on patches about the size of a thumbnail, which contain hundreds of microneedles. Such vaccines are now in development for many diseases, including polio, measles, and rubella. When the patch is applied to the skin, the tips of the needles dissolve under the skin, releasing the vaccine.

"When Covid-19 started, concerns about vaccine stability and vaccine access motivated us to try to incorporate RNA vaccines into microneedle patches," Daristotle says.

The "ink" that the researchers use to print the vaccine-containing microneedles includes RNA vaccine molecules that are encapsulated in lipid nanoparticles, which help them to remain stable for long periods of time.

The ink also contains polymers that can be easily molded into the right shape and then remain stable for weeks or months, even when stored at room temperature or higher. The researchers found that a 50/50 combination of polyvinylpyrrolidone and polyvinyl alcohol, both of which are commonly used to form microneedles, had the best combination of stiffness and stability.

Inside the printer, a robotic arm injects ink into microneedle molds, and a vacuum chamber below the mold sucks the ink down to the bottom, making sure that ink reaches all the way to the tips of the needles. Once the molds are filled, they take a day or two to dry. The current prototype can produce 100 patches in 48 hours, but the researchers anticipate that future versions could be designed to have higher capacity.

Antibody response

To test the long-term stability of the vaccines, the researchers first created an ink containing RNA that encodes luciferase, a luminescent protein. They applied the resulting microneedle patches to mice after being stored at either 4 degrees Celsius or 25 degrees Celsius (room temperature) for up to six months. They also stored one batch of the particles at 37 degrees Celsius for one month.

Under all of these storage conditions, the patches induced a strong luminescent response when applied to mice. In contrast, the luminescent response produced by a traditional intramuscular injection of the luminescent-protein-encoding RNA declined with longer storage times at room temperature.

Then, the researchers tested their Covid-19 microneedle vaccine. They vaccinated mice with two doses of the vaccine, four weeks apart, then measured their antibody response to the virus. Mice vaccinated with the microneedle patch had a similar response to mice vaccinated with a traditional, injected RNA vaccine.

The researchers also saw the same strong antibody response when they vaccinated mice with microneedle patches that had been stored at room temperature for up to three months.

"This work is particularly exciting as it realizes the ability to produce vaccines on demand," says Joseph DeSimone, a professor of translational medicine and chemical engineering at Stanford University, who was not involved in the research. "With the possibility of scaling up vaccine manufacturing and improved stability at higher temperatures, mobile vaccine printers can facilitate widespread access to RNA vaccines."

While this study focused on Covid-19 RNA vaccines, the researchers plan to adapt the process to produce other types of vaccines, including vaccines made from proteins or inactivated viruses.

"The ink composition was key in stabilizing mRNA vaccines, but the ink can contain various types of vaccines or even drugs, allowing for flexibility and modularity in what can be delivered using this microneedle platform," Jaklenec says.

Anne Trafton for MIT News Office

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Rock & Roll Hall of Fame Reveals Class of 2023

Willie Nelson, Kate Bush, Missy Elliott, Sheryl Crow, Rage Against the Machine and More

Willie Nelson just got an only slightly late 90th birthday present: an impending induction into the Rock & Roll Hall of Fame. The country music legend was one of seven music figures announced Wednesday morning as having been voted into the hall, along with Kate Bush, Rage Against the Machine, Missy Elliott, Sheryl Crow, George Michael and the Spinners.

https://bit.ly/3pkojOu

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10 Incredible Castles in Japan to Add to Your List

Discover Japan's rich history and architecture through its feudal castles.

https://bit.ly/41H49fO

Hey, they left out Kintai Castle at Iwakuni

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Earth in 4K – Space Station Expedition 67-68 Edition

pinterest

The people who've been to Earth orbit for the rare opportunity to see our home planet from a whole different angle say this blue marble in space is really quite beautiful and awe-inspiring when seen from 250 miles straight up. Here's your chance to see if you agree: these ultra-high definition video scenes, captured between March 2022 and March 2023 during the International Space Station's Expeditions 67 and 68, let you imagine yourself as a station crew member with an hour off duty and nothing better to do than look out the window as the world, literally, passes by.

https://youtu.be/UOT4VwhVukA

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Foo Fighters

The American rock band, Foo Fighters, began as a one-man project by former Nirvana drummer Dave Grohl. Following the success of the 1995 his debut album, Grohl (lead vocals, guitar) recruited a band consisting of Nate Mendel (bass guitar), William Goldsmith (drums), and Pat Smear (guitar). After a succession of lineup changes, the band formed its core lineup in 1999 consisting of Grohl, Mendel, Chris Shiflett (guitar), and Taylor Hawkins (drums). Smear rejoined in 2005, and Rami Jaffee (keyboards) joined in 2017.

Over the course of their career, Foo Fighters have won 15 Grammy Awards, including Best Rock Album five times, making them among the most successful rock acts in Grammy history. In 2021, the band was announced as recipients of the first-ever "Global Icon" award at the 2021 MTV Video Music Awards. They were inducted into the Rock and Roll Hall of Fame in 2021, their first year of eligibility.

Making a Fire https://www.youtube.com/watch?v=gfbJCzaEdps

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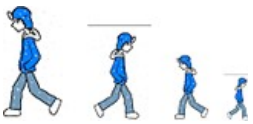
My Walking Thoughts



For Sunday May 14 2023

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Much is being made of AI these days, some by people thrill by the prospect of its benefit to mankind, but even more stridently by those who fear its threat to humanity.

For Example:

AI pioneer Geoffrey Hinton says its threat to world may be 'more urgent' than climate change.

LONDON, May 5 (Reuters) - Artificial intelligence could pose a "more urgent" threat to humanity than climate change, AI pioneer Geoffrey Hinton told Reuters in an interview on Friday.

Geoffrey Hinton, widely known as one of the "godfathers of AI", recently announced he had quit Alphabet (GOOGL.O) after a decade at the firm, saying he wanted to speak out on the risks of the technology without it affecting his former employer.

Hinton's work is considered essential to the development of contemporary AI systems. In 1986, he co-authored the seminal paper "Learning representations by back-propagating errors", a milestone in the development of the neural networks undergirding AI technology. In 2018, he was awarded the Turing Award in recognition of his research breakthroughs.

But he is now among a growing number of tech leaders publicly espousing concern about the possible threat posed by AI if machines were to achieve greater intelligence than humans and take control of the planet.

"I wouldn't like to devalue climate change. I wouldn't like to say, 'You shouldn't worry about climate change.' That's a huge risk too," Hinton said. "But I think this might end up being more urgent."

He added: "With climate change, it's very easy to recommend what you should do: you just stop burning carbon. If you do that, eventually things will be okay. For this it's not at all clear what you should do."

Microsoft-backed (MSFT.O) OpenAI fired the starting pistol on a technological arms race in November, when it made AI-powered chatbot ChatGPT available to the public. It soon became the fastest-growing app in history, reaching 100 million monthly users in two months.

In April, Twitter CEO Elon Musk joined thousands in signing an open letter calling for a six-month pause in the development of systems more powerful than OpenAI's recently-launched GPT-4.

Signatories included Stability AI CEO Emad Mostaque, researchers at Alphabet-owned DeepMind, and fellow AI pioneers Yoshua Bengio and Stuart Russell.

While Hinton shares signatories concern that AI may prove to be an existential threat to mankind, he disagreed with pausing research.

"It's utterly unrealistic," he said. "I'm in the camp that thinks this is an existential risk, and it's close enough that we ought to be working very hard right now, and putting a lot of resources into figuring out what we can do about it."

In the European Union, a committee of lawmakers responded to the Musk-backed letter, calling on U.S. President Joe Biden to convene a global summit on the future direction of the technology with European Commission President Ursula von der Leyen.

Last week, the committee agreed a landmark set of proposals targeting generative AI, which would force companies like OpenAI to disclose any copyright material used to train their models.

Meanwhile, Biden held talks with a number of AI company leaders, including Alphabet CEO Sundar Pichai and OpenAI CEO Sam Altman at the White House, promising a "frank and constructive discussion" on the need for companies to be more transparent about their systems.

"The tech leaders have the best understanding of it, and the politicians have to be involved," said Hinton. "It affects us all, so we all have to think about it."

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According to the Cambridge Existential Risks Initiative, *An 'existential risk' (x-risk) is an event that could permanently and drastically reduce humanity's potential, for example by causing human extinction. Examples of existential risks include extreme runaway climate change, a nuclear war, engineered pandemics, or risks from advanced AI. Other risks also exist, including global authoritarian lock-in.*

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My daughter, Jenn, sent me an article elaborating the threat AI poses to the world and I'm not here to ignore or refute it. I am, however, against the irrational suppression of research and development of the various technologies involved. First and foremost, whatever efforts in that direction won't work. It's too late since the cat is out of the bag and bright people the world over are racing to grab the brass ring. But like any other 'game changer,' the key to our security—survival in the minds of some—lies not in hiding from it but advancing the technology in such ways that the keys to its control remain in competent hands.

Since the day the first atomic bomb obliterated Hiroshima, we've all shuddered in the recognition of nuclear energy's threat to civilization. But over the years we've found ways to avoid Armageddon, a pretty good indication that reason exists even in the midst of strife. [*Ditto the use of even scarier bugs and gas*.]

I suspect the key to the successful adoption of AI in our lives will include such safeguards as focusing attention on the kinds of areas we would seek to deny to madmen, i.e. erecting roadblocks to their unwonted access and control.

How? How the heck do I know except that vigilance rather than prohibition will be the more telling part of that equation.

History is full of psychopaths, but with the ever-increasing safeguard of transparency I have faith we will ferret out and find ways to deflect 'the existential risk' (you have to love the pundits for their high-flying prose) and channel it to good ends.

As I said to my daughter, it seems to me that all progress is borne both by balm and venom, and while I agree that AI's unfathomed list of unknowns is scary, like those who have had to tackle fundament change before we will learn to deal with them.

I am not as confident in our ability to combat *global authoritarian lock-in.*

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An Added Thought to Last Week's Look at Thorium Reactors

I received a surprising response to the article along with a whole bunch of questions beyond the range of my limited knowledge, so I reviewed a number of papers on the subject.

The largest concern seems to be how you control the process, so here's what I found:

Thorium reactors use nuclear fission to generate energy, and the reaction process is controlled through a combination of design features and control systems.

One of the key design features of a thorium reactor is that it uses a liquid fuel, typically a molten salt mixture, instead of solid fuel rods. This allows for greater control over the reaction process as the fuel can be circulated and adjusted in real-time to regulate the rate of fission.

In addition to the liquid fuel, thorium reactors also typically use control rods made of materials such as boron or cadmium to absorb neutrons and regulate the reaction process. These control rods can be inserted or withdrawn as needed to adjust the rate of fission.

Finally, thorium reactors also use monitoring and feedback systems to continuously measure the reaction rate and adjust the control rods and fuel flow accordingly. This allows for precise control over the reaction process and ensures that the reactor operates safely and efficiently.

To me the takeaway is that there is a lot of basic engineering still to be done.

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