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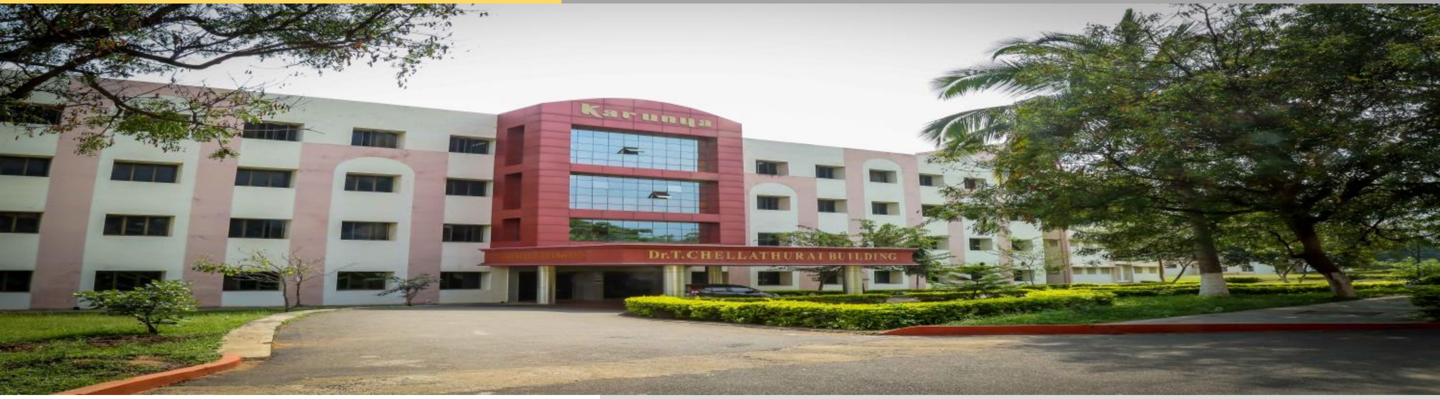
Newsletter by the Department of Biotechnology



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A New Polio Vaccine Joins the Fight to Vanquish the Paralyzing Disease

After decades of work and mass vaccination campaigns that have spared millions of children from paralysis, the world is close to wiping out polio. But a small number of outbreaks that have simmered in areas of low vaccination remain. And some happened after weakened virus in the oral polio vaccine, over time, moved around a community and regained the ability to cause disease. No other vaccines made with weakened live viruses have caused outbreaks of disease. To stamp out vaccine-derived polio outbreaks, the World Health Organization has granted emergency use for a new polio vaccine. Along with continuing the crucial work of improving vaccination coverage in places where it is low, the new vaccine will “hopefully … take us to the finishing line of polio eradication.”. The disease was a promising candidate for eradication. An effective, easily administered and cheap vaccine was available. And poliovirus, which naturally infects only humans, doesn’t hang around in other animals in between outbreaks.

A New Iron-based Catalyst Converts Carbon dioxide into Jet Fuel

Today, airplanes pump a lot of climate-warming carbon dioxide into the atmosphere. But someday, carbon dioxide sucked from the atmosphere could be used to power airplanes. A new iron-based catalyst converts carbon dioxide into jet fuel, researchers report online December 22 in *Nature Communications*. But if CO_2, rather than oil, were used to make jet fuel, that could reduce the air travel industry’s carbon footprint — which currently makes up 12 percent of all transportation-related CO_2 emissions. When placed in a reaction chamber with carbon dioxide and hydrogen gas, the catalyst helps carbon from the CO_2 molecules separate from oxygen and link up with hydrogen forming the hydrocarbon molecules that make up jet fuel. The leftover oxygen atoms from the CO_2 join up with other hydrogen atoms to form water.

Ocean Acidification May Make Some Species Glow Brighter

A more acidic ocean could give some species a glow-up. As the pH of the ocean decreases as a result of climate change, some bioluminescent organisms might get brighter, while others see their lights dim, scientists report January 2 at the virtual annual meeting of the Society for Integrative and Comparative Biology. Bioluminescence is de rigueur in parts of the ocean (*SN: 5/19/20*). The ability to light the dark has evolved more than 90 times in different species. As a result, the chemical structures that create bioluminescence vary wildly — from single chains of atoms to massive ringed complexes. With such variability, changes in pH could have unpredictable effects on creatures' ability to glow (*SN: 7/6/10*). If fossil fuel emissions continue as they are, average ocean pH is expected to drop from 8.1 to 7.7 by 2100. As pH drops, the bioluminescent chemicals in some species, such as the sea pansy (*Renilla reniformis*), increase light production twofold, the data showed. Other compounds, such as those in the sea firefly (*Vargula hilgendorfii*), have modest increases of only about 20 percent. And some species, like the firefly squid (*Watasenia scintillans*), actually appear to have a 70 percent decrease in light production.

This Weird Chemical Bond Acts Like a Mash-up of Hydrogen and Covalent Bonds

Hydrogen bonds are typically thought of as weak electrical attractions rather than true chemical bonds. Covalent bonds, on the other hand, are strong chemical bonds that hold together atoms within a molecule and result from electrons being shared among atoms. Now, researchers report that an unusually strong variety of hydrogen bond is in fact a hybrid, as it involves shared electrons, blurring the distinction between hydrogen and covalent bonds. The researchers used infrared light to set bifluoride ions vibrating and measured the hydrogen atoms' response, revealing a series of energy levels at which the hydrogen atoms vibrated. For a typical hydrogen bond, the spacing between those energy levels would decrease as the atom climbed further up the energy ladder. But instead, the researchers found that the spacing increased. This behavior indicated that the hydrogen atom was shared between the two fluorine atoms equally, rather than being closely bound to one fluorine atom by a covalent bond and more loosely bound by a typical hydrogen bond to the other. Computer calculations showed that this behavior is dependent on the distance between the two fluorine atoms. As the fluorine atoms move closer to each other, squeezing the hydrogen between them, the normal hydrogen bond becomes stronger, until all three atoms begin sharing electrons as in a covalent bond, forming a single link that the researchers call a hydrogen-mediated chemical bond. For fluorine atoms that are farther apart, the conventional description, with distinct covalent and hydrogen bonds, still applies.

A Tale of Two Antiviral Targets and the COVID-19 Drugs that Bind Them

COVID-19, for all of the problems it has created, has shown the unprecedented speed with which drug developers can move. Vaccines and bespoke antibodies were among the first responders on the COVID-19 scene, authorized just under 11 months from the release of the SARS-CoV-2 sequence. Now oral antivirals, from Pfizer and Merck & Co., are set to make their mark. Pfizer's contender, paxlovid, went from a compound in a freezer and optimization ideas on a drawing board to a regulatory submission in just 20 months. Merck's molnupiravir was already a preclinical candidate when COVID-19 struck, but also a beneficiary of a development sprint. Preliminary data suggest that both offer benefits over Gilead's remdesivir — an intravenously injected antiviral that secured an EUA in May 2020 and full FDA approval in October 2020 for hospitalized patients. This antiviral had already been derisked in clinical trials before the pandemic started. It is not widely used outside the USA. The arrival of oral antivirals that can be used in non-hospitalized patients is raising the hopes of infectious diseases experts. Oral antivirals could provide a cheaper and easier-to-administer option than the antibodies that have already been authorized for non-hospitalized patients. Shortages of anti-COVID-19 antibodies have caused political tension in the USA, where the government doled out about 2.4 million doses last year. The oral antivirals may also be less susceptible to resistance-causing mutations, adds Horby. Antibodies target Spike, the protein that SARS-CoV-2 uses to gain access to human cells, which is tolerant of mutations. The antivirals target components of the viral replication process that are less tolerant to change.

Pitcher Plants Create a Slippery Trap for Insects

Many plant surfaces have remarkable wetting properties enabling them to float on water, self-clean, or move water around. The pitcher plant's peristome differs from these because it makes water spread out rather than repelling it. This continuous thin film of water makes the peristome so slippery that unsuspecting insect visitors slide straight into the plant's trap. Like other natural surfaces with extreme wetting properties, the properties of the peristome are determined by a combination of surface chemistry and topography. Understanding the relative importance of these factors could help biologists and engineers mimic similar smart surfaces. The peristome surface is patterned with radial macro- and microscopic grooves separated by ridges that restrict the lateral spread of water but enhance radial spread to create a continuous slippery surface even when there is very little water. A droplet of water on the peristome rapidly enters the grooves because the dimensions are below the capillary length of water and spontaneously runs down them because surface tension trumps gravity. Even with at least one macroscopic groove along the length of the peristome filled with water, insects could still displace the water film to grab on with their adhesive foot pads. This is where the microscopic ridges come in because they render the film of water between the peristome and insects' foot pads stable.

Polymer Nanoparticles on the Brain

The blood-brain barrier filters out harmful substances to prevent them reaching the brain. But this same barrier also blocks the passage of drug. Polymeric NPs are a promising candidate for all types of drug delivery but could have unique advantages for overcoming the blood brain barrier. Ramassamy and his team used a simple synthetic approach to create particles with a PLA core and a shell of PEG chains. The size of the particle, as well as the length and density of PEG chains can be varied, allowing the researchers to select combinations with the most promising properties, which were then tested *in vivo* using zebrafish. The zebrafish is a good model for the blood brain barrier [because it] retains many of the features of mammals. The researchers' observations confirm that particles cross the blood brain barrier through active cellular processes known as endocytosis and exocytosis. In zebrafish, the team found that the NPs are also translocated across vascular walls and end up in specific regions, including the brain. Drug nanotransporters have numerous advantages to target toxic or degradation-sensitive drugs across cell barriers. The results could have implications for blood brain barrier particle adhesion and translocation to the brain, but it still need to optimize transport efficiency and understand the interactions between NPs and the vascular endothelium.

Gelatin-based Film that Can Self-repair Smartphones

A self-healing gelatin-based film that can repair itself numerous times while maintaining the electronic signals required to access data in a device has been demonstrated by a group from the National Cheng Kung University in Taiwan. The film offers useful properties for overcoming fragility problems – such as cracks in the casing, or fractures develop in the material that stores data – in touchscreen and flexible display devices, and could also find uses in advanced robotics and assisted health technologies. Gelatin has already been employed in new electronic devices due it its translucency, flexibility, water solubility and biodegradability. It is also easily available and safe, and can be easily stored in an ambient atmosphere for long periods without deterioration. However, damaged gelatin films tend not to restore quickly, while other self-repairing films usually work only once, and can contain harmful agents. While gelatin shows promise for making flexible resistive memory components, their previous work had shown that continuous deflection made the gelatin irregular and caused cracks in the film, resulting in rapid loss in the performance for resistive memory devices.