

Science & Technology Briefs

Progress on an All-Purpose COVID-19 Vaccine

Dr. Kayvon Modjarrad, Director of the Emerging Infectious Diseases Branch of the Walter Reed Army Institute, announced Dec. 21 a major step forward in a two-year project for a single vaccine that would provide immunity from a broad array of human coronaviruses, including Omicron and future—as well as past—variants.

In an [interview](#) with *Defense One*, Dr. Modjarrad describes using nanofabrication methods to engineer artificial spikes on the 24 faces of soccer ball-shaped ferritins. Ferritins are natural proteins normally used to store iron. The artificial spikes train the immune system, creating antibodies prepared ahead of time to fight the real viruses. Up to 24 different coronavirus strains can be accommodated in the single-shot vaccine.

Phase 1 clinical trials, begun in April, have been completed with successful results. It took eight months, as the team had difficulty locating enough unvaccinated people not previously infected. Now they will test how well this Spike Ferritin Nanoparticle (SpFN) vaccine works on previously vaccinated people.

Russia Helps Europe Build Galileo Navigation System

On Dec. 4, despite the growing, dangerous geopolitical face-off between U.S./NATO/Europe and Russia, a Russian Soyuz launcher lifted off from Kourou, French Guiana, and successfully positioned into orbit two new European satellites to add to the existing 26 of the Galileo constellation.

Galileo Launch 11 is the first of a

series of six launches (with two satellites per launch), which will allow Galileo, which requires at least 30 satellites, to become fully operational.

Galileo, the EU's civilian Global Navigation Satellite System (GNSS), operated by the European Union Agency for the Space Program (EUSPA), is headquartered in Prague, Czech Republic, with two ground operation centers, in Fucino, Italy, and Oberpfaffenhofen, Germany. In 1999, engineers selected the best from the different concepts submitted by the three main participating countries (Germany, France, Italy), and in 2005, the first satellites were launched.

One of Galileo's aims is to provide a positioning system for European nations independent of the U.S.'s GPS, Russia's GLONASS, or China's BeiDou.

The €10 billion project will provide high-precision latitude and longitude measurements with better positioning services at higher latitudes than the other positioning systems. Such precision is required for search and rescue operations, and to allow efficient robotization of vehicles moving on the Earth's surface, whether trucks, ships or trains. Galileo's services are free and open to all.

Measurement of Peripheral Blood Flow in Microgravity

In December, Russian cosmonaut Alexander Misurkin, Japanese billionaire Yusaku Maezawa, and his business assistant Yozo Hirano—three crewmembers of the Soyuz MS-20 spaceflight—participated in an experiment aboard the International Space Station to study the effects of microgravity on the circulation of erythrocytes (red blood cells) into the hands, feet and

heads of space travelers.

Measurements were made with the help of the Russian Lazma-PF analyzer (laser Doppler flowmetry), which requires no needles or other surgical instruments. The test subjects simply wore non-invasive devices fastened with bandages to their temples, wrists, middle finger and big toe.

Andrei Dunayev, leading researcher at the Scientific and Technological Center for Biomedical Photonics at Turgenev Oryol State University, [told](#) TASS Dec. 10:

“These biophotonics methods have long proven their worth in biomedicine and are based on probing the skin with optical radiation (completely safe and low-intensity light, similar to that of a laser pointer) and registering its release [the stimulated release of light —ed.] from the tissues to calculate and analyze various biomedical parameters.”

TASS continues its report: “The Laser Doppler Flowmetry method will register a signal from moving erythrocytes and help assess skin perfusion (the average amount of erythrocytes and their average speed). This will make it possible to study the peripheral blood flow. For its part, the method of fluorescence spectroscopy will focus on generating various wavelengths to trigger fluorescence of various skin biomarkers, including NADH [a coenzyme central to metabolism —ed.] that will indirectly characterize tissue oxidative metabolism (to assess the so-called tissue respiration).”

The tests continued after the crew returned to Earth, to study how the body adapts to different gravity conditions.

The experiment is especially vital because erythrocytes are produced in bone marrow, and their rate of production is slowed by decalcification of the bone (bone thinning), as commonly

happens during long space missions in microgravity.

Hydrogels To Repair Heart, Vocal Cords

As [reported](#) Nov. 22 in the *Wiley Online Library*, scientists at McGill University in Montreal, Canada have developed a new, injectable hydrogel that is porous enough for blood perfusion and can be used to restore the voices of those with damaged vocal cords, or repair damaged heart muscle. These areas are particularly challenging to heal because of the constant beating of the heart and the rapid and intense vibration of the vocal cords.

Jules Menten, [writing](#) about this breakthrough for *California News Times*, says:

“Hydrogels are a type of biomaterial that when injected into the body form a stable porous structure that allows living cells to grow or pass through and repair damaged organs. Scientists have tested the durability of hydrogels with a machine developed to simulate the extreme biomechanics of the human vocal cords. Vibrating 120 times per second for more than 6 million cycles, the new biomaterial remained intact, while standard hydrogels were shattered and unable to cope with the stress of the load.”

The team was led by Prof. Luc Mongeau and Assistant Prof. Jianyu Li, assisted by Guangyu Bao, a doctoral candidate in the Department of Mechanical Engineering at McGill University.

When Wildfires Raged Across Antarctica

The first palaeobotanical evidence that wildfires reached Antarctica in the Cretaceous period, 145 to 66 million years ago, was reported in 2015. Now, a new report published Oct. 20 in *Polar Research* provides further evidence,

this time for the James Ross Island area.

The Cretaceous was a time when the continents were just beginning to separate into distinct land masses; South America was beginning to move away from Africa, and Australia was still connected to Antarctica. Earlier, mammals had begun to appear on the scene, 178 million years ago. The climate was warm and humid, due to a high level of volcanic activity and the rapid spreading of the sea floor. The polar regions had no continental ice sheets, and dinosaurs roamed the forests of Antarctica.

The Oct. 20 [paper](#), “Wildfires in the Campanian of James Ross Island: A New Macro-Charcoal Record for the Antarctic Peninsula,” presents evidence developed by a research team of Flaviana Jorge de Lima of the Federal University of Pernambuco, Brazil, and other scientists in Brazil and Germany.

Extensive wildfires in the Northern Hemisphere during the Cretaceous have already been studied.

“With increasingly sophisticated techniques, scientists can reconstruct ancient ecosystems and fire patterns with mounting precision,” says Elisabeth Dietze, vice president of the International Paleofire Network, who is not affiliated with the study: “Molecular markers in charcoal reveal the kind of vegetation burned: For example, rounder, plated molecular shapes indicate woody biomass.”

In the James Ross Island study, the authors found that “the new charcoal material has a gymnospermous taxonomic affinity, more specifically with the Araucariaceae,” an ancient family of conifers.

World’s First Small Modular Nuclear HTGR on the Grid in China

The China Nuclear Energy Association reported Dec. 20 that the Huaneng Group’s 200 megawatt Unit 1

nuclear reactor at Shidao Bay in Shandong Province, had begun feeding electrical power to the grid. This is the world’s first pebble-bed, small modular high-temperature gas-cooled reactor (HTGR) in commercial operation. The company published a short promotional [video](#) last September.

The reactor is safer than earlier technologies, as it is has “passive safety.” The physics of the reactor is such that overheating induces shutdown, instead of a runaway reaction. Thus, there is no dependence on electrically powered monitoring systems (which could fail) to prevent meltdown.

Because of passive safety, a containment vessel is not needed, which means construction is far cheaper. The reactor is helium cooled, so that it can be located inland, away from any large body of water that would otherwise be needed for cooling.

Reactor No. 2 at Shidao Bay achieved criticality Nov. 11, and is expected to join No. 1 in delivering power to the grid by mid-2022.

Most of China’s electricity, however, is produced from fossil fuels, 69% coal in 2019. In March 2014, China declared a “war on pollution,” announcing that it would accelerate the closing of coal-fired power stations.

There is recognition in China, however, that switching to wind and solar creates blackouts, as these “renewable” sources are *reliably intermittent*, rather than constant. To clean up its atmosphere, while continuing to grow economically—unlike the U.S. and Europe—China is going nuclear in a big way, investing as much as \$440 billion in new plants over the next 15 years.

China’s nuclear reactor being planned for export is currently the Hualong One, a pressurized water reactor, rated at 1000 MW. The third such reactor in service was connected to the grid on Jan. 1, 2022.