Science & Technology Briefs

Paxlovid Pill OK'd for Emergency Use: High-Risk COVID Patients at Onset

The Food and Drug Administration has authorized the emergency use of Paxlovid for the treatment of adults and children 12 years or older with a diagnosis of mild-to-moderate COVID-19 who are at high risk for progression to severe disease, including hospitalization or death. Taken within a few days of infection, the antiviral from Pfizer reduces the chance of hospitalization by 89%. The U.S. government has placed orders for $10 billion worth of the new drug.

Locking onto a protease enzyme at the core of COVID's replication machinery, Paxlovid neutralizes it, preventing the virus from propagating and causing disease.

Similar protease enzymes exist in other types of coronavirus. That means Pfizer's drug may also be a ready defense against the next coronavirus pandemic.

The new antiviral drugs—there's also one from Merck that targets a different mechanism in viral replication—took longer than the COVID vaccines to design, synthesize, and test, but they still set records for speed. Never before has an entirely new molecule to defeat a disease gone so quickly from a chemist's bench into the mouths of volunteers and gained approval from the FDA.

Paxlovid will prevent many people from dying of COVID-19, including people with weak immune systems for whom the vaccines don't work. And, should new variants turn up that elude existing vaccines, antivirals such as Paxlovid could be deployed.

Gene Deletion Enables Crops To Grow in Saline Soil

China Daily reported March 24, that "Chinese scientists have discovered a crop gene that, once deactivated, can allow plants to thrive in saline and alkaline soils, a feat that has the potential to create new saline-alkaline tolerant crops."

This is very good news. The study was published March 24 in *National Science Review.*

China Daily elaborated:

"The gene, called AT1, plays a key role in regulating the plant's response to saline and alkaline environments. Field experiments have shown that without the gene, crops such as sorghum, rice, wheat, maize and millet have higher yields and biomass when planted in fields with low to medium saline-alkaline content....

"The AT1-deactivated rice variant can produce about 22.4–27.8% more grain in saline and alkaline soils. New grain variants, including millet, documented an increased production of nearly 20%, and research has shown that removing the AT1 gene in maize can significantly increase its ability to survive in saline-alkaline environments.

"According to the Food and Agriculture Organization of the United Nations, as of 2015, the world had about 1 billion hectares of soil damaged by high concentrations of sodium, chloride and sulfate. Around 60% of these soils are sodic and have a high alkaline value due to the presence of sodium carbonate and sodium bicarbonate (commonly known as baking soda).

"If just 20% of the estimated 618 million hectares of sodic land were to grow AT1-deactivated crops, scientists estimate it would lead to the production of at least 250 million metric tons of additional food annually, significantly contributing to world food security, according to the study."

Xie Qi, a researcher at the Institute and one of the key scientists behind the discovery, told *China Daily*: "It was quite a sight to behold when you see crops emerging from the white, barren alkaline land, where they typically struggle to survive."

Further studies have to be done to determine the effect the removal of the AT1 gene has on the quality of the different crops.

Best Practice: Prevent Nuclear War

A study by a team from the University of Nicosia, Cyprus, titled "Nuclear Explosion Impact on Humans Indoors," paints a terrifying picture of the supersonic shock waves in air that traverse the interiors of buildings, with pressures capable of knocking a standing person across a room with a force "equivalent to several *g*-forces of body mass acceleration." And that is with only one warhead.

Prof. Dimitris Drikakis, one of the study's authors, is quoted in a *Motherboard* article Jan. 18 on how to survive a nuclear bomb. He said the goal was to "understand the enormous forces transported by a nuclear blast, even inside a building in a Moderate [Damage] Zone."

He concluded that the safest approach is to avoid nuclear war in the first place:

"We ought to raise awareness of the detrimental effects of nuclear explosions and make every effort to prevent them from happening."

First Proton-Boron Fusion in a Magnetically Confined Plasma

TAE Technologies, a fusion R&D firm in Lake Forest, California recently reported the first measurable proton-boron fusion in a magnetically confined plasma. It involved an experimental design involving both international collaboration of fusion projects, and the reversed-field magnetic pinch configuration developed by the late fusion pioneer Dr. Norman Rostoker and foreseen by ideas of Drs. Winston Bostick and Daniel Wells, both collaborators of the Fusion Energy Foundation of Lyndon LaRouche.

The company, founded in 1998 by students of Rostoker, and Japan's National Institute for Fusion Science (NIFS), for the first time were able to measure fusion reactions in a fuel mixture of hydrogen (nucleus: 1 proton) and boron (nucleus: 5 protons, 6 neutrons)—known as proton-boron fusion, requiring a plasma temperature at least in the range of 500-600 million degrees Kelvin.

The fusion of these elements produces no neutrons, but only alpha particles (helium-4 nuclei) and large amounts of energy. The measured fusion (nowhere near breakeven of energy output to input) was achieved using the Large Helical Device at the National Institute for Fusion Science (NIFS) in Japan. That is a stellarator design, but it is targeted for modification to function as the next iteration of TAE's reversed-field magnetic configuration, and should be capable of generating 100 times more power, according to a Feb. 28 article in *Nature*.

A NIFS spokesperson is quoted: "This achievement is a big first step toward the realization of a fusion reactor using advanced fusion fuel." The *Nature* article explains that the plasma is formed by superheating boron powder and is confined in the magnetic field of the device, and the hydrogen is injected into the plasma by a particle beam.

A Novel Nuclear Waste Transmutation Reactor

One major—and groundless—objection to nuclear power is that "there is no solution to the nuclear waste problem." Spent nuclear fuel that has not been reprocessed remains radiotoxic above levels found in natural uranium ore for approximately 300,000 years, and the vast majority of uranium and plutonium remains unused within in it. While technical solutions for long-term disposal exist, there is another route: nuclear fuel recycling.

Both the uranium and the plutonium from spent fuel can be recycled by reprocessing and used in new nuclear fuels for further power generation. However, the residue from standard reprocessing leaves minor actinides—elements near uranium in the Periodic Table—which cannot be burned in current power reactors. This radioactive residue of these actinides requires 10,000 years to return to natural levels.

Currently under construction at the Belgian Nuclear Research Center (SCK-CEN) is Phase One of a project called MYRRHA (Multi-purpose Hybrid Research Reactor for High-tech Applications), based on an accelerator-driven system concept that aims to demonstrate at the engineering level, the feasibility of the transmutation of the minor actinides on an industrial scale, and develop new radioisotopes for innovative cancer treatments. By reducing radiotoxicity, the volume of high-level radioactive waste can be reduced by 99% and the time required for storage to just 300 years.

MYRRHA's design differs from most current reactors in that it uses fast neutrons to fission the minor actinides, and can operate in a subcritical mode, i.e., without reaching a self-sustaining fission chain reaction—as it depends on a high-energy accelerator. To ensure maximum reliability, SCK-CEN scientists designed the MYRRHA reactor to work in conjunction with a linear accelerator (linac). A linac has fewer interruptions in the beam's proton flow than a cyclotron. An additional advantage is that, as soon as the accelerator stops, the fission chain reaction stops and the reactor shuts down. As an essential safety measure, it is being designed so that the residual decay heat can be removed by passive natural circulation without any active system or intervention.

Since MYRRHA's reactor core does not have enough fissile material to maintain the chain reaction by itself, the particle accelerator, named MINERVA, fires protons at the heavy lead-bismuth atomic nuclei. The protons cause neutrons to split off from the lead and bismuth atoms, which in turn cause fissions in the fuel, setting off a chain reaction. Whenever MINERVA is shut down, MYRRHA is thereby automatically shut down.

To transmute a substantial proportion of the world's spent nuclear fuel, now largely treated as toxic waste, will require a network of industrial facilities. So far, the technologies involved in MYRRHA have been proven individually on the laboratory scale at experimental facilities. Hence MYRRHA is a pre-industrial pilot plant aimed at integrating and testing the various technologies at scale, while substantially increasing reliability.

The Belgian government has invested about €200 million in MYRRHA so far, and in 2018 supplemented that with €558 million for the period 2019-2038 based on an overall project estimate of about €1.6 billion. The European Strategy Forum on Research Infrastructures has listed MYRRHA among those projects identified by research communities as "leading edge."

More about MYRRHA is available here.