Science & Technology Briefs

Regenerative Medicine Treats Aging as a Curable Disease

Scientists at the SENS (Strategies for Engineered Negligible Senescence) Research Foundation are catalyzing a worldwide effort to "develop, promote, and ensure widespread access to therapies that cure and prevent the diseases and disabilities of aging," and thus extend, ultimately indefinitely, the human lifespan.

The accumulation of damage caused by normal molecular processes drives the progressive rise in frailty, disease, and disability that we suffer as we age. When applied as specific therapies, rejuvenation biotechnologies will "directly remove, repair, replace, or render harmless" that damage and restore the robust cellular and molecular structure and functioning—and with that, health and vigor.

A single panel of treatments with rejuvenation biotechnologies is not expected to provide a permanent fix for aging damage, however. The normal metabolic processes that cause that aging will continue. Therapies will therefore need to be periodically repeated to confine damage to levels low enough to prevent the development of age-related dysfunction, disease, and death.

According to SENS, "there are no more than seven major classes of such cellular and molecular damage: extracellular aggregates, death-resistant cells, damage to extracellular matrix, intracellular aggregates, mitochondrial mutations, cancerous cells, and cell loss and tissue atrophy."

Each of these seven kinds of damage contributes to the rising frailty and ill-health that begins to appear as we reach our sixties and accelerates thereafter. "The specific metabolic processes that are ultimately responsible for causing the damage are still only partially understood," but the SENS scientists say "we don't need to answer the many open questions about the *causes* of structural decay in order to develop effective therapies to reverse it. No matter what caused a given unit of damage in the first place, the same regenerative therapeutics can be used to repair it and restore the machinery of life to proper working order."

"For each major class of aging damage, a strategy for its removal or repair either already exists in prototype form, or is foreseeable from existing scientific developments." One may still die from being run over by a car or from falling off a cliff, but as regenerative research progresses, other than being the recipient of extreme trauma, everyone who chooses to do so will be able to live healthy, youthful lives, initially for many more decades, then for hundreds of years, then indefinitely. This will, obviously, change everything.

Sun/Cosmic-Ray Climate Connection Undermines IPCC Conclusions

A study published Oct. 11 in *Nature Scientific Reports* by researchers led by Henrik Svensmark at the Danish National Space Institute at the Technical University of Denmark, and Nir Shaviv at the Hebrew University of Jerusalem, suggests that changes in the Sun's magnetic field increase or decrease the density of cosmic rays reaching Earth, causing an increase or decrease in cloud formation, sufficiently affecting the Earth's energy budget to affect the climate.

Their conclusions put into question all of the Intergovernmental Panel on Climate Change's (IPCC) contrary assumptions. The IPCC estimations are of an average of only 0.01 watts/m^2 in the years 1750 to 2019, from which the IPCC concludes:

"The effect of galactic cosmic rays (GCR) on CCN (cloud condensation nuclei) is too weak to have any detectable effect on climate and no robust association was found between GCR and cloudiness. … There is high confidence that GCRs contribute a negligible ERF (effective radiative forcing)…."

The Svensmark-Shaviv observational data, however, indicate that Earth absorbs about 1.7 watts/m^2 additional energy within 4-6 days of the cosmic-ray minimum, a result almost two orders of magnitude higher than the IPCC's, much too big a difference to be ignored.

Ice and Vapor Plumes Above Thunderstorms Help Forecast Tornadoes

When a cloudy plume of ice and water vapor billows above the top of a severe thunderstorm, there is a good chance a violent tornado, high winds, or hailstones bigger than golf balls will soon develop.

A new Stanford University-led study funded by the U.S. National Science Foundation and published Sept. 10 in *Science* reveals the physical mechanism for these plumes, which form above most of the world's most damaging tornadoes.

"To unravel the mystery of how tornadoes are generated, it is important to understand the flow structures inside supercells—one type of tornado

parent storm," said Chungu Lu, a program director in NSF's Division of Atmospheric and Geospace Sciences. "This research has demonstrated the possible link between the overshooting cloud structure on the top and the tornado generated below the cloud by using ultra-high-resolution computer simulations corroborated with radar observations."

Research has shown that icy plumes are easy to spot in satellite imagery, often 30 minutes or more before severe weather reaches the ground. "The question is, why is this plume associated with the worst conditions, and how does it exist in the first place? That's the gap we are starting to fill," said atmospheric scientist Morgan O'Neill, lead author of the new study.

The research comes after supercell thunderstorms and tornadoes spun up among the remnants of Hurricane Ida as they barreled into the U.S. Northeast, compounding devastation wrought across the region by record-breaking rainfall and flash floods.

Understanding how and why plumes take shape above powerful thunderstorms could help forecasters recognize similar impending dangers and issue more accurate warnings without relying on Doppler radar systems, which can be knocked out by wind and hail—and have blind spots even on good days. In many parts of the world, Doppler radar coverage is nonexistent.

"If there's going to be a terrible hurricane, we can see it from space. We can't see tornadoes because they're hidden below thunderstorm tops. We need to understand the tops better," said O'Neill.

The thunderstorms that spawn most tornadoes are supercells, a rare breed of storm with a rotating updraft that can hurtle skyward at speeds faster than 150 miles per hour with enough power to punch through the usual lid on Earth's troposphere, the lowest layer of the atmosphere.

In weaker thunderstorms, rising currents of moist air tend to flatten and spread out upon reaching this lid, called the tropopause, forming an anvil-shaped cloud. A supercell thunderstorm's intense updraft presses the tropopause upward into the next layer of the atmosphere, creating what scientists call an overshooting top. "It's like a fountain pushing up against the next layer of our atmosphere," O'Neill said.

About 75% of thunderstorms with these plumes produce large hail or tornadoes, says Leigh Orf of the University of Wisconsin at Madison, a co-author whose expertise includes modeling and simulating storms on supercomputers. The plumes' appearance on satellite imagery can help guide severe weather forecasts.

Bacteria that Clean Up Radioactive Waste

For decades, scientists have suspected that bacteria known as Geobacter could clean up radioactive uranium waste, but it wasn't clear how they did it.

In 2011, a team at Michigan State University led by microbiologist Gemma Reguera discovered that Geobacter makes protein filaments on one side of its cells that act like wires to "zap" uranium. That jolt triggers chemical reactions that give the bacteria energy, and that chemistry traps the uranium in a mineral form, preventing the radioactive material from spreading through the environment. But those protein wires accounted for just about 75% of the uranium the Geobacter were cleaning up.

"We always knew we were missing something," said Reguera. "What we didn't know was what was happening at the cell surface, particularly on the side of the cell that had no wires to immobilize the uranium."

Reguera's team now has the answer: Molecules called lipopolysaccharides coat the cell surface and soak up the uranium like a sponge. "This finding is significant in revealing the strategy for uranium detoxification and mineralization that Geobacter sulfurreducens uses, and which may be applicable to other metals," said Enriqueta Barrera, a program director in NSF's Division of Earth Sciences.

Published Sept. 28, 2021 in *Applied and Environmental Microbiology,* the results could enable the creation of new ways to remediate dangerous pollution, and to recycle and reclaim increasingly scarce metals from electronic waste. The next step, Reguera says, is investigating whether Geobacter and its sponges can be encouraged to pull other toxic metals from waste streams.

Jupiter's Moons Reveal Potential for Life

Studying photo images of Europa, one of Jupiter's moons, taken in 2013 by the Hubble Space Telescope, NASA scientists report plumes of water vapor erupting through its encasing ice, where the temperatures hover around –260°F. Similar to Earth's geysers, these eruptions shoot water vapor up to 100 km, producing transient clouds of vapor in Europa's atmosphere.

Water vapor has also been discovered on Ganymede, another of Jupiter's moons.

SciTechDaily reported on these findings Oct. 15:

"This detection paves the way for in-depth studies of Europa by future probes planned for launch within a decade, including NASA's Europa Clipper and the Jupiter Icy Moons Explorer (JUICE) mission from the European Space Agency (ESA). Understanding the formation and evolution of Jupiter and its moons also helps astronomers gain insights into Jupiter-like planets around other stars."

"Europa is so exciting as a potential abode of life" that these missions are being planned.

Lorenz Roth published the results of the study Sept. 13 in G*eophysical Research Letters*.