syndrome, and cancer, DCDC might provide ways for better understanding and perhaps treating these conditions, she suggests.

“Building a synthetic gene circuit that counts and reports cell divisions is one of the holy grails of synthetic cell biology,” says Roy Kishony at the Technion-Israel Institute of Technology in Haifa. “The method will revolutionize our ability to detect and quantitate cell divisions in the gut microbiome and its response to nutrients, antibiotics, and ecological communities.”

DCDC also might be adapted to study microbial cells being used in bioreactors to manufacture drugs and food products, according to Silver. The microbial consortiums within industrial-scale bioreactors typically produce toxic byproducts, undermining overall efficiency of such processes, she says. “Tools like DCDC could optimize the bacterial consortium to get more desired products.”

Carol Potera is a freelance writer in Great Falls, Mont.

NEW FROM ASM

Potential Broad-Spectrum Antiviral Agents Act by Triggering Innate Immunity

David C. Holzman

Low-molecular-weight compounds that trigger innate immunity response genes might serve as broad-spectrum antiviral agents, acting through the innate immune system to suppress a wide range of RNA viruses, including influenza A and hepatitis C, as well as the emerging dengue, Ebola, Lassa, Nipah, and West Nile viruses, according to Michael Gale, Jr., of the University of Washington, Seattle, and his collaborators. The research appeared 16 December 2015 in the Journal of Virology (doi: 10.1128/JVI.02202–15).

The work followed research showing that a human gene, called the retinoic acid inducible gene-I (RIG-I), functions as a receptor that recognizes and binds viral RNA within infected cells. Other findings from Gale and his collaborators indicate that some pathogenic viruses can block particular immune system activities, including the RIG-I pathway. The receptor recognizes RNA from RNA viruses, generally, including the influenza, Ebola, dengue, and hepatitis C viruses as well as HIV.

Gale and members of his group and their corporate partners at Kineta, Inc., Seattle, screened small molecules to identify those that can activate the RLR pathway, the signaling pathway that triggers retinoic acid inducible gene-I to bind viral RNA. “We reasoned that by targeting and activating RIG-I or its pathway components, we could develop a broad-spectrum antiviral drug class that would be effective in suppressing a variety of human pathogenic RNA viruses,” he says.

The researchers tested the small
molecules using well-known human cell lines to see which ones could activate the antiviral pathway. A small number of molecules were effective. “Our goal now is to develop drugs that trigger RLR signaling for clinical use, when people present in the clinic with a viral infection,” says Gale. “This is the first demonstration of this in a therapeutic application.”

“Our team is now working to optimize these compounds into something that would be applicable in patient care,” says Gale’s collaborator Yueh-Ming Loo of the University of Washington. These efforts include improving formulation and medicinal chemistry, and investigating the compounds’ mechanisms, she says.

“I am impressed by the spectrum of viruses that can be inhibited by their new drug candidate,” says Grant McFadden of the University of Florida, who was not involved in the research. Such drugs could potentially fill a major need, he says. Antiviral drugs are uncommon, and they are particularly hard to develop for RNA viruses, “which can mutate their own genomes very rapidly. This is particularly true for newly emerging viruses, and for those viruses that scientists have had little opportunity to study.” Another potentially important advantage, he adds, is that targeting a host cell antiviral defense factor, rather than the virus, as this drug would do, makes it much less likely that the virus can develop resistance against the drug, a common occurrence.

David C. Holzman, who writes from Lexington, Mass., is a contributing writer for Microbe.

RESEARCH ADVANCES

Not-So-Large Charge: Deep-Sea Microbes Directly Consume Electricity

David C. Holzman

The bacterium Acidithiobacillus ferrooxidans can thrive on electrons obtained directly from an electrode when its usual energy source—iron—is unavailable. This switch from using an inorganic element to consuming electricity itself as a source of electrons “demonstrates a previously unknown bioenergetic versatility,” say Ryuhei Nakamura of the RIKEN Center for Sustainable Resource Science in Saitama, Japan, and his collaborators. Thus, electrons might be a primary energy source for these bacteria while dwelling within the deep-sea hydrothermal ecosystems in which they are found, they point out. Details appeared in the September 2015 Frontiers in Microbiology (doi:10.3389/fmicb.2015.00994).

These findings suggest that electricity can be considered a third energy source for life on earth, says Ken Takai of the Japan Agency for Marine-Earth Science and Technology in Yokosuka, who was not involved in the research. Historically, only two energy sources are documented to support microbial life: oxidation-reduction chemistry and photosynthesis from sunlight.

Recent discoveries prompted this particular research project, according to Nakamura. In 2010, he and his collaborators discovered geo-electric currents crossing through the walls of black smoker chimneys that form next to underwater hydrothermal vents. “That suggested that some deep-sea microbes might double as electro lithoautotrophs, organisms that can use electric potential as an energy source, instead of light, or surrounding inorganic substances, meaning that they simply eat electrons,” he says, speculating: “Electro lithoautotrophs might be comparatively common in the microbial world.”

To study how A. ferrooxidans behaves, the investigators developed highly sensitive electrochemical systems to monitor the cells in culture, including electric currents being generated by the cells, Nakamura says. The researchers cultured A. ferrooxidans cells in an Fe(II)-free environment, and supplied an electrode with an electrical potential of 0.4 V, while providing carbon dioxide as a carbon source and oxygen as an electron acceptor. These conditions generated an electric current from the electrode. The strength of the electrical current was proportional to the number of cells attached to the electrode, and killing the cells with UV light immediately stopped the current.

“Electro lithoautotrophs are capable of driving microbial life,” says Nakamura. The research may prove useful in the development of fuel cells, batteries, thermoelectric converters, and perhaps other devices, according to Nakamura.

“This paper and others to come will completely change our current understanding of uncovering another energy source capable of driving microbial life, the research may prove useful in the development of fuel cells, batteries, thermoelectric converters, and perhaps other devices, according to Nakamura.

MINITOPIC

Oddly Enough, Both Bacteria and Electrons Spin in Similar Patterns

Billions of bacteria streaming through a microfluidic lattice synchronize their movements and swim in patterns similar to those of electrons orbiting atomic nuclei in a magnetic material, according to Jörn Dunkel of Massachusetts Institute of Technology in Cambridge and his collaborators at Cambridge University in the United Kingdom. Motile bacteria in small wells that are about 70 μm wide swim together in a spiral pattern. Within a lattice containing many such wells, the bacteria take directions that depend on the relative size of gaps between those wells, flipping in synchrony to follow the same direction if the gaps are 8 μm or larger, the researchers note. These findings fit with a “generic lattice field theory, suggesting that bacterial spin networks belong to the same universality class as a wide range of equilibrium systems.” Details appeared 4 January 2016 in Nature Physics (doi:10.1038/nphys3607).