Converting cell activity to electrode signaling

Joel Collier and Milan Mrksich report a technique for converting cellular activities into recordable electronic signals. The authors engineered Chinese hamster ovary cells to express the fungal enzyme cutinase at the end of fractalkine protein stalks on the cell’s surface. The cells were placed on self-assembled electrode monolayers containing cutinase’s substrate on its surface. The enzyme converts a nonelectroactive hydroxyphenyl ester to an electroactive hydroquinone, providing electrical activity that can be identified via cyclic voltammetry. In this way, cell-surface enzymatic activity was transduced into electronic signals, and electrical activity could be recorded as the cells grew and moved on the electrode surface. The method may offer an alternative to depending on a cell’s innate electrical activity or bioluminescent and fluorescent signals for detection schemes. Collier and Mrksich say that a useful biosensor device could be developed by making cutinase expression inducible by specific environmental stimuli. The technique could be useful for cell-based sensing technologies, growth of tissue-engineered biomedical products, and substrate preparations for cell adhesion studies. — P.D.

“Engineering a biospecific communication pathway between cells and electrodes” by Joel H. Collier and Milan Mrksich (see pages 2021–2025)

Orb spider recovery after hurricane

Thomas Schoener and David Spiller report on the asynchronous recovery of orb spider community characteristics in the Bahamas after a category IV hurricane. For the 4 years before and 4 years after Hurricane Floyd passed over the islands in September 1999, the authors monitored 16 species of orb spiders on 41 Bahamian islands. Before the hurricane, the relationship between species richness and island area was strong, with no temporal trend. Seven months after the hurricane, the species-area slope had dropped to zero but then increased over time to its prehurricane value. The authors also monitored the effect of the orb spider’s major predator, the lizard Anolis sagrei, on abundance and species richness. Before the hurricane, the lizard effect (difference in spider abundance or species richness between islands with and without A. sagrei) was strong. In the years after the hurricane, the lizard effect on spider abundance became strong again, but the effect on species richness remained weak. One year after the hurricane, the species richness averaged over all islands had recovered to the last prehurricane level, but abundance had attained only approximately half the previously recorded value. — R.N.

“Nonsynchronous recovery of community characteristics in island spiders after a catastrophic hurricane” by Thomas W. Schoener and David A. Spiller (see pages 2220–2225)

Genotype 1a hepatitis C virus in cell culture

MinKyung Yi et al. report the production and propagation of genotype 1a hepatitis C virus (HCV) in cultured human cells. Although HCV genotype 2a (JFH-1) has recently been propagated in cell culture, genotype 1a strains are principally associated with liver disease (e.g., cirrhosis, liver cancer) in most of the world. Yi et al. transfected human hepatocytes with synthetic RNA from H77-S, a prototype 1a virus with five adaptive mutations that provide for efficient RNA replication. Whereas JFH-1-transfected cells displayed a continual release of infectious virus, H77-S-transfected cells showed greatest release 24–48 h after infection, followed
by subsequent bursts of virus release after every splitting of the cells. This activity is consistent with observations that viral replication is tied to cell proliferation. H77-S cells secreted more viral RNA into supernatant fluids than did JFH-1 cells, though much of it was noninfectious, and H77-S cells also accumulated viral proteins more slowly. Overall, H77-S virus had a lower specific infectivity than JFH-1. The availability of a cultured genotype 1a HCV strain may aid in the understanding of host–virus interactions, HCV life cycle, and how HCV causes chronic liver damage. — N.Z.

“Production of infectious genotype 1a hepatitis C virus (Hutchinson strain) in cultured human hepatoma cells” by MinKyung Yi, Rodrigo A. Villanueva, David L. Thomas, Takaji Wakita, and Stanley M. Lemon (see pages 2310–2315)

MEDICAL SCIENCES

Lack of organization in human islet cytoarchitecture

Over Cabrera et al. report that human islets do not have the same anatomical structure as islets in other species. Islets of Langerhans, small, pancreatic organs crucial for glucose homeostasis, consist of four secretory endocrine cell types: β (insulin), α (glucagon), δ (somatostatin), and PP (pancreatic polypeptide). In mice, α, δ, and PP cells cluster around a core of β cells to form islets, but the architecture of human islets has been poorly understood. Cabrera et al. compared human islet cellular composition to that of other mammalian species. Insulin-expressing cells were the most abundant cell type in islets of all species, but the proportion of β cells was higher in mice (77%) than in humans (55%). Also, 71% of mouse β cells associated with other β cells, whereas only 29% of human β cells did so. Irrespective of type, the vascularization pattern of most human islets localized near islet blood vessels and aligned in no particular sequence. Human, monkey, and mouse islets increased intracellular calcium in response to elevated extracellular glucose, but only primate islets responded when glucose was decreased. These calcium concentration dynamics were different in human and mouse islets, suggesting that different islet architecture has functional implications. — F.A.

“The unique cytoarchitecture of human pancreatic islets has implications for islet cell function” by Over Cabrera, Dora M. Berman, Norma S. Kenyon, Camillo Ricordi, Per-Olof Berggren, and Alejandro Caicedo (see pages 2334–2339)

MICROBIOLOGY

Nitrogen fixation and metabolic switching in thermophilic microbial mats

Anne-Soisig Steunou et al. report that the unicellular thermophilic cyanobacteria Synechococcus, which are found in hot spring microbial mats, fix nitrogen at night with energy derived from fermentation. The authors compared genomic sequences of two Synechococcus ecotypes from Yellowstone National Park that live at temperatures around 60°C and found identical gene clusters for nitrogen fixation. In mat samples, RNA transcripts encoding nitrogenase subunits rose during the night, whereas those for proteins that participate in photosynthesis and respiration declined. Nitrogenase activity was also specifically detected during the night. Furthermore, transcripts encoding some fermentation proteins dropped in the evening, whereas others rose. Steunou et al. say that fermentation provides energy for nitrogen fixation during the night, when the mat is anoxic, conditions under which nitrogenase is stable and active. The authors also discuss how light and oxygen can affect transcript accumulation and control many metabolic systems over the diel (24-h day–night) cycle. Metabolic switches related to these changes may have broad effects throughout the microbial mat ecosystem. — P.D.

“In situ analysis of nitrogen fixation and metabolic switching in unicellular thermophilic cyanobacteria inhabiting hot spring microbial mats” by Anne-Soisig Steunou, Devaki Bhaya, Mary M. Bateson, Melanie C. Melendrez, David M. Ward, Eric Brecht, John W. Peters, Michael Kühl, and Arthur R. Grossman (see pages 2398–2403)

Human islet of Langerhans, with insulin (red), glucagon (green), and somatostatin (blue) immunoreactive cells.

Microbial mat from Yellowstone hot spring, with top layer containing cyanobacteria Synechococcus.