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NSF AT WORK

Green Roofs Cool the City

Green roof on Columbia University building. Credit: Stuart Gaffin

Buildings topped by roofs covered partially or completely with vegetation have many benefits. These so-called "green roofs" can trap air-borne particles that affect human health, better insulate buildings, cool down urban areas, and collect rainwater before it floods city sewers. The National Science Foundation (NSF) is funding an investigation at Columbia University aimed at improving green roof technology and the research is starting to provide new insights.

Summer temperatures on rooftops can reach as high as 170° Fahrenheit, which causes cooling systems to consume large amounts of energy. Green roof technology can reduce this temperature, the Columbia research shows, and make cooling larger urban buildings much more efficient.

While other groups had already studied green roofs in rural and suburban environments, Columbia University's program is unique in its focus on a densely populated urban center. Determining how well this technology works in large cities and how it can be improved to meet the needs of more populated areas are essential in making green roof technology feasible for wider use.

Columbia University currently has seven green roofs, two of which are also research stations dedicated to developing a better understanding and improving the technology of green roofs, making this technology viable on a larger scale. Read more about the Columbia project here.

Sometimes Timing Is Everything

New research, funded by NSF, has shown that taking advantage of an insect's biorhythms can lead to more effective pest control.

Side view of a fruit fly, *Drosophila melanogaster*. Credit: Mark Frye, UCLA

Jadwiga Giebultowicz of Oregon State University studies the circadian clock in fruit flies. Circadian clocks regulate a wide range of processes, from biochemistry to behavior, on a roughly 24-hour cycle and play an important role in biology from insects to humans. Giebultowicz's group has extensively studied the genes that control circadian clocks and recent work from the group's lab suggests that knowledge of the fly's circadian clock can be put to our advantage.

The researchers tested the flies' sensitivity to various pesticides at different times of the day and found that the levels needed to kill the flies varied with the time of exposure. This sensitivity was reflected in gene activity associated with the circadian clock.

For example, a group of genes appears to peak in late afternoon, causing the flies to have the most resistance to chemical exposure at this time. A practical consequence of this is that significantly less pesticide would be needed in the morning to achieve the same result observed in the afternoon. These results suggest that the time of day should be considered when studying the effects of pesticide use, both for more effective killing of insects as well as for toxicity and safety studies. Read more about the work here.

Targeting Diseased Cells

Artist's rendition of RNA molecule. Credit: Nicolle Rager Fuller, National Science Foundation

NSF awardee, Bioo Scientific, based in Austin, Texas, is developing a new type of drug delivery system that uses a form of ribonucleic acid, or RNA, that interferes with the functioning of diseased cells. Small interfering RNA, or siRNA, are small RNA fragments that can disrupt a cell's ability to express its genetic code. Problems in expression of genes plays a role in many diseases such as cancer and cystic fibrosis, so controlling genetic expression with siRNA could enable treatments for these diseases. The technology may also be useful in experiments to develop such treatments.

Initial NSF support through the Small Business Innovation Research, or SBIR, program allowed Bioo Scientific to overcome the longstanding obstacle of getting the siRNA into the target cells. With additional funding from the American Reinvestment and Recovery Act of 2009, Bioo Scientific will be turning their targeted transport technology (T3) into a drug delivery research tool that will be available to other investigators for further validation and study for use in eventual therapeutic applications.

Predicting Catastrophe

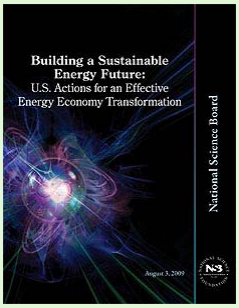
Credit: State of New York

What do abrupt changes in ocean circulation and Earth's climate, shifts in wildlife populations and ecosystems, the global finance market and its system-wide crashes, asthma attacks and epileptic seizures have in common? All share generic early-warning signals that indicate a critical threshold of change dead ahead, according to research supported by NSF.

Stephen Carpenter of the University of Wisconsin at Madison and George Sugihara of the Scripps Institution of Oceanography in La Jolla, Calif., along with other researchers, report that similar symptoms occur in many systems as they approach a critical state of transition. "It's increasingly clear that many complex systems have critical thresholds--'tipping points'--at which these systems shift abruptly from one state to another," says Carpenter. Especially relevant, the scientists discovered, is that "catastrophic bifurcations," a diverging of the ways, propel a system toward a new state once a certain threshold is exceeded.

The way in which plants stop growing during a drought is an example. At a certain point, fields become deserts, and no amount of rain will bring vegetation back to life. Before this transition, plant life peters out, disappearing in patches until nothing but dry-as-bones land is left. Humans aren't exempt from abrupt transitions. Epileptic seizures and asthma attacks are cases in point. Our lungs can show a pattern of bronchoconstriction that may be the prelude to dangerous respiratory failure, and which resembles the pattern of collapsing land vegetation during a drought. "If we have reason to suspect the possibility of a critical transition," the scientists write, "early-warning signals may be a significant step forward in judging whether the probability of an event is increasing."

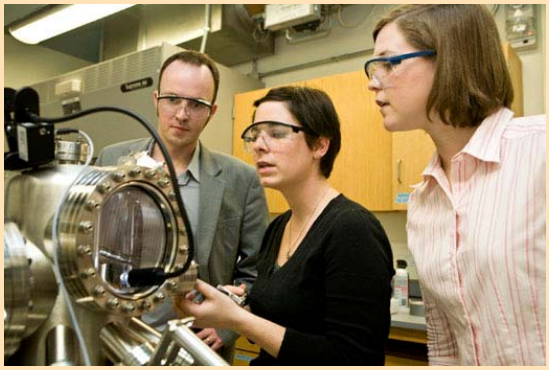
Did You Know?



The National Science Board (NSB) recently released the results of a two-year study to examine the country's activities in sustainable energy and to address science and engineering challenges related to the development of sustainable energy sources. The report lists six key findings of the study and makes the following recommendation: "The U.S. government should develop, clearly define and lead a nationally coordinated research, development, demonstration, deployment and education (RD3E) strategy to transform the U.S. energy system to a sustainable energy economy that is far less carbon intensive." Among the findings of the study are that a comprehensive coordinated federal strategy will be required to develop sustainable energy sources, and that current private and federal support for sustainable energy research and development is inadequate. The full report can be downloaded from NSF's Web site here.

Faces of NSF Research

Turning Molecules Into Motors



Charles Sykes and graduate students, Erin Iski and April Jewell, use an STM in their lab. Credit: Joanie Tobin, Tufts University

Tufts University chemistry professor Charles Sykes is trying to make the smallest motor ever. Sykes is fascinated by the tiny molecular motors and nano-machines found throughout our bodies and, indeed, in all living things. "Such machines are seen everywhere in nature," he says. "They perform tasks as varied as powering the motion of cells and even driving whole body locomotion through muscle contraction. However, mankind has not been able to create this molecular motion in nanoscale devices."

Sykes would like to change that. In his lab, he and his students use a sophisticated instrument known as a scanning tunneling microscope, or STM, to see individual molecules and to study what causes some molecules to spin like rotors.

One type of molecule that Sykes is studying is called a thioether. These tiny structures, composed of a handful of carbon atoms chained together with a sulfur atom, begin to spin like helicopter blades when they are cooled to very low temperatures, approximately 25 degrees Kelvin, or 415 degrees (F) below zero. "We discovered that, at very low temperatures, the molecules transition between a locked or 'frozen' state to one in which they spin at more than 1 million times per second," Sykes explains.

Further work by Sykes and his students showed that this spinning motion could be transmitted from one tiny molecule to another. And another. The potential to create a chain reaction and get many molecules to spin together could lead to new applications in communication technologies or in other technological arenas.

Sykes is a recent recipient of an NSF Faculty Early Career Development (CAREER) award, which provides his research with five years of funding to study this phenomenon. He is enthusiastic about sharing what he and his students are discovering in the lab. The group has recently released a YouTube video describing its work and showing how the group's research might, some day, lead to the development of alternative energy sources. Read more about the work here.

NSF in the News

Internet Turns Forty Years Old This Month (*Los Angeles Times*) On Oct. 29, 1969, a scientist at UCLA sent the first message over the computer network that became known as ARPANet. In 1991, ARPANet was converted into NSFNet and opened to commercial use, launching the modern Internet.

Connections Among Solar Cycle, Stratosphere and Ocean Discovered (*U.S. News & World Report*) Subtle connections among the 11-year solar cycle, the stratosphere and the tropical Pacific Ocean work in synchrony to generate periodic weather patterns affecting much of the globe, according to research funded by NSF. The results appeared in the journal *Science* in August.

Powerful Ideas: Spray-on Solar Cells (*San Jose Business Journal*) Solar cells could soon be painted onto the sides of buildings or rooftops with nanoparticle inks, according to engineering research funded by NSF. The photovoltaics developed in this research are made of copper indium gallium selenide particles that can be dissolved in solvent and sprayed onto any surface.

The Future of Biofuels May Be in Algae (*The New York Times*) Corn is often considered the most important source for biofuels, but an expert from NSF says that more promising sources for liquid hydrocarbon fuels include switch grass, woody biomass and even algae.

Just in Time for Halloween

Why do our hearts race, our knees shake, and our bodies sweat when we are scared? "Goose Bumps! The Science of Fear," an exhibit developed by the California Science Center and supported in part by NSF, explores this universal emotion that can save our lives. Through fun and interactive challenges, guests can experience fear in a safe environment and discover the science behind their physical and emotional responses.

The 6,000-square-foot exhibit is funded by a grant from NSF's Informal Science Education Program, which seeks to support projects that promote lifelong learning about science in a wide variety of informal settings, such as museums. The "Science of Fear" exhibit will be at the Oregon Museum of Science and Industry in Portland, Ore., from October 10, 2009 through January 3, 2010. Visit the exhibit Web site for further information about the exhibit and its five-year tour schedule.

Building Research Competitiveness

Limahull Ahupua'a on the island of Kauai. Credit: Univ. of Hawaii

Six research projects, each representing a state-wide consortium of institutions, have received Research Infrastructure Improvement (RII) Track-1 awards from NSF. The investment in projects ranging from the study of biodiversity and climate change in Hawaii to sustainable development in Maine, totals over $20 million for five years of support. The awards were made through NSF's Experimental Program to Stimulate Competitive Research (EPSCoR) activity. The mission of EPSCoR is to assist NSF in strengthening research and education in science, technology, engineering and mathematics (STEM) throughout the U.S. and to avoid undue concentrations of research and education funding in just a few geographic areas.

The states that received these RII awards are Hawaii, Kansas, Maine, Mississippi, South Carolina and South Dakota. More details about the research to be carried out in each state under these awards can be found here.

Nation Honors Top Scientists and Engineers

On September 17, 2009, President Obama announced the names of nine winners of the 2009 National Medal of Science. Awarded annually, the medal is administered by NSF and honors those who have made outstanding contributions to science and engineering. It is the highest honor bestowed by the U.S. government on scientists and engineers. The President also announced four winners of the National Medal of Technology and Innovation, which is administered by the Department of Commerce. Recipients of both medals will be honored on October 7 in a ceremony at the White House. A list of the awardees can be found here.