news briefs

Nanoparticles Come to the Rescue for AIDS

Since Richard Feynman wrote his historical paper, "There is Plenty of Room at the Bottom," the discoveries that have been made at the bottom have grown exponentially. Far from being restricted to the world of micro-processing, nanotechnology has opened up a world of wonder for biologists, chemists and even theoretical physicists. In the world of HIV and AIDS, where the virus is at most a couple hundred nanometers long, nanotechnology has suddenly become the key for treating this modern plague. Scientists in Switzerland have effectively utilized nanoparticles to deliver protein therapeutics to cancerous human cells lines and live mice. According to Link *et al.* "protein transducing nanoparticles (PTNs), devoid of viral genome sequences, enabled transient and dose-dependent delivery of therapeutic proteins at functional quantities into a variety of mammalian cells in the absence of host chromosome modifications" (1). This efficient delivery of protein therapeutics yielded some remarkable results. The researchers were able to achieve directed cell death as well as decreased tumor growth without genetically modifying the cells or the animal. This discovery could aid treatment of viruses such as AIDS, without requiring the genetic medication of cells, which up until now as been unsuccessful. This method allows for the specific targeting of cells while enabling the scientist to deliver a protein that is protected from degradation as it makes its way to the target site. This treatment has been shown by Link *et al.* to clearly decrease tumors both *in vitro* and *in vivo*, promising a new future for efficient medication and treatments for viruses. This recently developed alternative to gene therapy could indeed be the future of modern medicine.

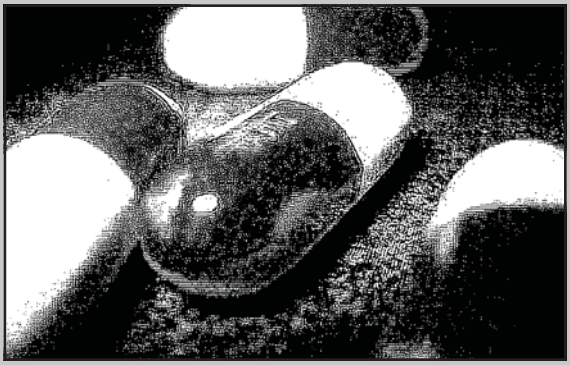
—Cristina Fernández

1. Link, N., Corinne Aubel, Jens M. Kelm, Rene´ R. Marty, David Greber, Valentin Djonov, Jean Bourhis, Wilfried Weber and Martin Fussenegger. "Therapeutic protein transduction of mammalian cells and mice by nucleic acid-free lentiviral nanoparticles." *Nucleic Acids Research* (34) 2006: e16.

A Taste of Your Own Medicine

From cars and computers to clothing and cosmetic surgery, one can get almost anything customized in today's society. But could medications someday be tailored to the individual, as well? The Royal Society has published a report about the possibility of genetically personalized drugs. The field that encompasses the production of such medications is known as pharmacogenetics, which "seeks to determine how people's genetic makeup affects their response to medicines" (1). The report concludes that there is good reason to believe that genetically tailored drugs are a possibility, although such an era is at least 15 to 20 years away. In indicating the possibility, the report cites advancements in human genome research and significant increases in the understanding of the complex workings of drugs and genes. Because the efficacy and side-effects of different drugs are not the same in all populations, personalized medications could bring substantial benefits to patients. The report concludes that for personalized drugs to become a reality, sampling from a considerable number of clinical trials and more extensive funding and field-related scientists are necessary.

—Justin Rossi



▶ One day pills like these may be genetically tailored to your own needs

credit: Adapted from a photo by Marissa Laohoo

1. "Personalised Medicines: Hopes and Realities." *The Royal Society*. (September 2005) URL: http://www.royalsoc.ac.ul/displaypagedoc.asp?=15874
2. "Personalised Medicines." *Science and Public Affairs*. (March 2006): 6-7

A Deep Breath: Alleviating Stress with Biofeedback

With the increasing accessibility of information and education, a growing number of Americans are taking their health into their own hands. To meet this demand, companies like Helicor Inc. are striving to bring modern medicine directly to the mass market.

Helicor has recently introduced the StressEraser, a portable biofeedback device designed to alleviate stress. Biofeedback is a treatment technique in which patients learn to consciously control biological processes that normally operate subconsciously. Patients use biofeedback devices that measure signals from their own body—such as heart rate and blood pressure—and train themselves to control these processes in order to improve their health.

Simply put, the StressEraser is a portable biofeedback device that trains people to synchronize their breathing with their parasympathetic nervous system in order to reduce stress. When our bodies need to rest, digest, and restore, the vagus nerve is activated—its signal travels from the brainstem to major organs and tells our heart to slow down and stomach to begin digesting. Thus, increasing vagus nerve activity increases relaxation and reduces stress.

Fortunately, activation of the vagus nerve can be influenced by something as simple as breathing. When we inhale, the vagus nerve is inhibited and our heart rate goes up, and when we exhale, the vagus nerve activity continues and reduces heart rate. (1).

Based on this principle, Helicor created a portable and easy-to-use biofeedback device that quantifies vagus nerve activity by measuring continuous heart rate, a measurement of the pulse beat by beat. The StressEraser then plots the small changes in heart rate as a line that fluctuates on the device's display (Figure 4). When the time between two heartbeats doubles, vagus nerve activity approximately doubles as well. The StressEraser then gives auditory and visual cues that tell the user when to breathe, in order to synchronize their breathing with their vagus nerve activity and thus increase relaxation (2).

▼ Helicor's StressEraser

If scientifically proven to be more effective than current stress-reduction methods, the StressEraser could be a potential breakthrough for improving physical and mental health. Mind-body research by Dr. Jon Kabat-Zinn has shown that stress reduction can improve recovery from cancer, psoriasis, chronic pain, and anxiety disorders (3-6).

In a previous article, I argued that when promotion of well-being is directed by oneself, one gains a sense of personal mastery and positive self-regard that causes even greater improvement than treatment that is not self-directed (7). Pending the results of clinical trials, the StressEraser has the potential to be one such self-directed tool in the fight against stress. Perhaps in the future, physical and mental health treatments will increasingly take place outside of the doctor's office, as individuals take greater initiative in the care of their own well-being.

—Saviz Sepah

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Home, But Not Alone

▼ *Coptotermes formosanus*

In the weeks after floodwaters receded, New Orleans was a ghost of its former self. Homes were damaged beyond repair, storefronts were looted, schools were closed, and over one million people fled the city for higher ground (1). Seven months later, rebuilding efforts are underway, and former residents are trickling in to begin a phase of reconstruction. Those returning expected to find their homes deserted; instead, they are faced with unwelcome guests that have flourished in their absence.

The U.S. Department of Agriculture had initially hoped that the flood had drowned a pestilence that has plagued New Orleans for the past fifty years. *Coptotermes formosanus*, or the subterranean Formosan termite, is believed to have entered the port city as a stowaway in shipping crates returning from the Pacific Rim after the Second World War. Since then, these termites have enjoyed a cellulose-feeding frenzy bankrolled by the City, which spends up to $500 million a year in pest control; attacks are especially vicious in the famed French Quarter, where many of the oldest buildings are wood. Following the floods, however, inspectors were surprised to find live termites in traps that had languished beneath ten feet of water for several weeks. A pest-control company entomologist estimates that Hurricane Katrina and its aftermath decimated half the population. However, the termite community is expected to recover in full-force by 2007 (2).

Returning residents are finding that wet, deserted conditions have created a new frontier for mold in their homes and offices. In September, Christine Rogers, a senior researcher at the Harvard School of Public Health, led a team to assess the mold situation in New Orleans. They discovered levels of contamination that are unprecedented in published literature. "It was biological warfare," she recalls, "with all these fungi fighting for space." A tidy indoor environment yields concentrations of less than one thousand spores per cubic meter of air, but after weeks of still water, New Orleans homes are hosting several million spores per cubic meter. These conditions pose a significant health risk. Mold sensitivity can lead to respiratory ailments ranging from allergies to asthma and fungal lung infections (3).

Hurricane Katrina swept the Gulf Coast at the end of August; it stripped the city bare, and in its wake revealed a city in crisis. Those hoping for a clean slate on which to rebuild the city will be hindered by problems both immediate and entrenched, neither of which we can afford to overlook.

—Pien Huang

credit: Photo by Scott Bauer, USDA Agricultural Research Service

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Unusual Mimicry in Ecuadorian Frog Species

Scientists have long known that animals at risk of being preyed upon sometimes emulate the appearance of their predators as a survival strategy (1). This form of mimicry, known as Batesian mimicry, is particularly common in insects. Traditional examples include harmless butterflies imitating the color pattern of poisonous wasps, or common grasshoppers copying the appearance of poisonous tiger beetles.

Classical Batesian theory predicts that imitators are most successful when copying the most toxic of the neighboring species (2). This prediction follows naturally from the assumption that the highest level of predator avoidance will be achieved by mimicking creatures that are the most poisonous, and hence also the most unpalatable. However, recent findings by a team of investigators studying the Ecuadorian frog *Allobates zaparo* suggest that modeling after the most dangerous critter may not always be the best strategy.

In a letter to *Nature* published in March of this year, Molly Cummings at the University of Texas

at Austin reveals that when *A. zaparo* is living sympatrically with two related poisonous frog species, *Epipedobates bilinguis* and *Epipedobates parvulus*, it is found to imitate the coloration patterns of the less toxic *E. bilinguis* (3). This surprising result prompted Cummings to run predator avoidance tests by exposing the three, red-colored amphibians to a flock of hungry chickens. When confronted with the more toxic *E. parvulus*, chickens quickly learned to avoid the red-backed frog and all frogs with remotely similar coloration patterns (3). However, when chickens were exposed to the less toxic *E. bilinguis*, they were more cavalier in their food choice. While they did strictly avoid *E. bilinguis*, chickens did not avoid all red-backed frogs.

These observations led Cummings to suggest that frogs deriving protection from mimicking *E. parvulus* would not be protected from chickens that were only exposed to *E. bilinguis*. In contrast, because chickens exposed to the extremely toxic *E. parvulus* learn to avoid all red-backed frogs, *E.bilinguis* mimics would derive dual protection from both types of predators. Cumming's findings suggest an adaptive role for Batesian mimicry of less toxic models under specialized conditions of predation risk.

—David Mu

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Taking the Guesswork Out of Computing, One Photon at a Time

Computers are seen as logical machines, rooted in concrete numbers and acting according to strict rules. However, a recent paper from the University of Illinois Physics Department suggests that the next generation of computers might not be as logical as we think (1). Quantum computing, considered part of the next wave of computer technology, promises to be able to handle vast amounts of information. Using photons, the smallest detectable quantities of light, these quantum computers can store twice the information that our current computers can store electronically (2). Quantum physics has known for a long time that photons do not behave in a full predictable manner. Simply measuring a photon can radically alter its behavior, making it appear to shift back and forth between wave and particle-like states. Recent studies have shown that using photons for computing can be just as unpredictable.

Experiments conducted by Onur Hosten and his colleagues and the University of Illinois give scientists even more puzzling behavior to think about (1). What they have created is essentially a computer that, when it is programmed to calculate a value and turned on, will give you something that looks like the answer even if the program is never run, a phenomenon called "counter-factual" computing. The explanation lies in the fact that a single photon is used to activate the program, and that this photon is split randomly between two paths, one that runs the program, and one that does not.

Photons are governed by probability, just like flipping a coin. But imagine if, every time you flipped a coin, half of that one coin turned heads up, and the other half turned tails up! In essence, the photon is acting like that morphing coin, spreading itself undetectably over several possible paths (2). The result is somewhat like seeing just one tiny part of the head or the tail of a coin; it gives scientists just enough information to say that it looks sort of like a head. Hosten and colleagues figured out a way to trap photons at just the right moment - when they somewhat resemble the value that is trying to be determined. This information was then used to guess at what the real answer might be. Surprisingly, with clues from counter-factual computing, the computers were able to make a far more accurate guess than if they had just guessed at random (1). Using counterfactual computing, the computers of the future might be able to get at the answers to the most difficult questions in ways that go far beyond the straightforward logical processes they use today.

—David Bochner

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