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In This Issue

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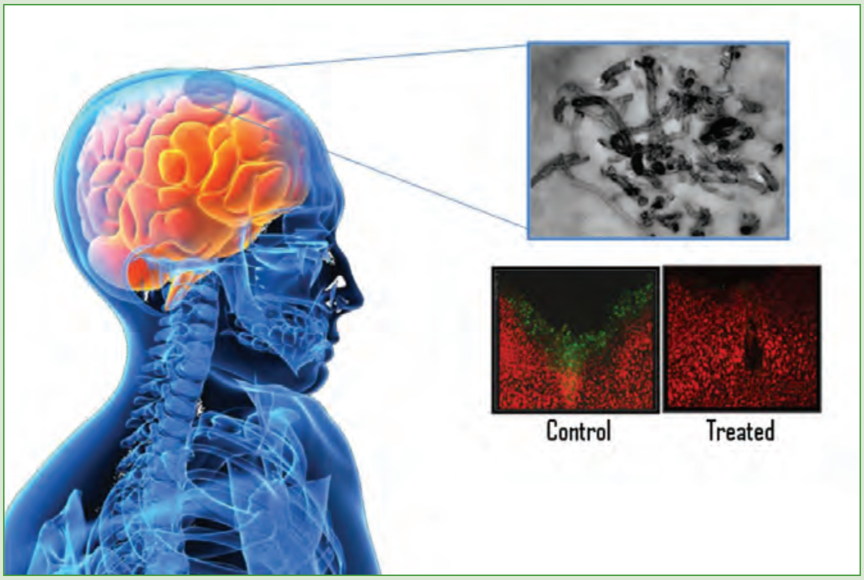
Combining nanotechnology and genetics to counter stroke

Researchers have established that the damage to brain tissue caused by an ischemic stroke can be partly attributed to the action of Caspase-3, an enzyme that helps trigger programmed cell death in neurons. That is the rationale underpinning experimental efforts aimed at silencing Caspase-3 in the neurons of stroke-afflicted rodents. Khuloud Al-Jamal et al. (pp. 10952–10957) attempted to facilitate the targeted delivery of adequate amounts of a silencing agent to stroke-damaged brain tissue in animals using carbon nanotubes, which can serve as nanoscale needles. The authors used 20–30 nm wide nanotubes to deliver siRNA—snippets of silencing RNA—against Caspase-3 to a region of the brain's cortex that controls the movement of forelimbs in mice. A day later, the authors induced stroke in the mice and found that mice that received siRNA via the nanotubes were better protected against stroke-induced neuronal cell death compared with mice that received a placebo. Further, the authors report, rats treated with anti-caspase-3 siRNA using the nanotubes could better move their forelimbs to reach, grasp, and retrieve food pellets from a well after the induction of stroke, compared with stroke-afflicted control rats. The findings suggest that carbon nanotube-mediated delivery of siRNA might hold therapeutic potential for human neurodegenerative diseases, according to the authors. — P.N.



Carbon nanotubes deliver siRNA to the brain.

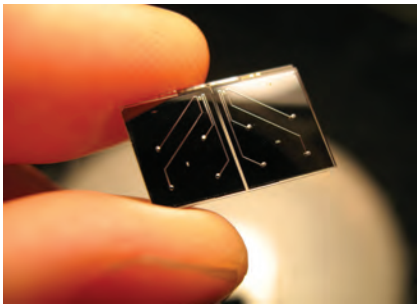
Nature's Pitot tubes: Sensors on bat wings

Bats perform an array of aerial maneuvers during flight that are unmatched among mammals, including sharp turns, hovering, and upended perching. Although researchers have long suspected that the rows of microscopic, domed hairs carpeting the wing membranes of bats contribute to their aerodynamic prowess, evidence for that belief has remained elusive. Susanne Sterbing-D'Angelo et al. (pp. 11291–11296) measured the electrophysiological response of the big brown bat to stimulation of the domed hairs on the bats' wing membranes with brief puffs of air. The authors report that air puffs from eight directions triggered responses from clusters of neurons in the somatosensory cortex of the bats' brains; bats whose wing membranes had been chemically depilated showed no such responses. The authors suggest that receptors at the base of the hairs detect turbulent air flow, likely helping to stabilize flight. In flight tests in which the bats were trained to negotiate their path through an obstacle course, bats whose hairs had been removed from the wing's trailing edge flew faster and made wider turns, compared with bats whose wing hairs were intact. The findings suggest that the domed hairs might act as flight speed and stall sensors, similar to Pitot tubes on aircraft wings. According to the authors, domed hairs on bat wings might represent an evolutionary adaptation for aerodynamic control. — P.N.

Bat in flight.

Single-cell density measurement helps track disease

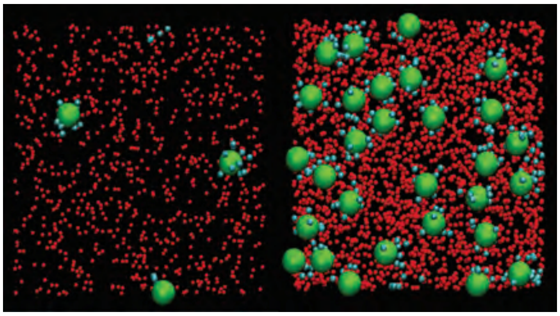
Cell density changes during important processes such as differentiation, apoptosis, disease, and malignancy, but until now a means for precisely measuring the density of an individual cell did not exist. Inspired by a technique that Archimedes reportedly used to measure the density of a king's crown, William Grover et al. (pp. 10992–10996) used a tiny mass sensor to weigh single cells in two fluids of different densities. From these two weight measurements, researchers calculated the mass, volume, and density of each cell. Because variation in cell density is nearly 100-fold less than variation in mass or volume, cell density measurements can indicate processes that would be otherwise undetectable by mass or volume measurements, the authors report. The authors measure the individual densities of approximately 500 cells per hour with high precision. In additional experiments, the technique distinguished transfused blood cells from a patient's own blood cells, and identified red blood cells infected with malaria, cells affected by sickle cell disease, and leukemia cells reacting to drug treatment. The authors speculate that the method may also help identify athletes who engage in blood doping, and may provide a clearer indicator of early-stage cell apoptosis than current techniques. — J.M.



Photograph of a suspended microchannel resonator mass sensor.

Designing reliably sticky particles

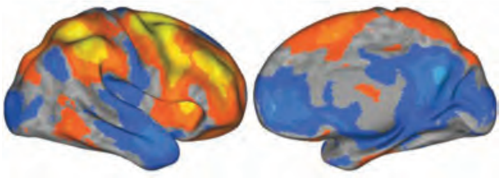
For applications such as cancer cell targeting and drug delivery, researchers need tiny particles that selectively stick to surfaces. One method is to design particles that only bind to surfaces when a certain concentration of attractive molecules are present. Francisco Martinez-Veracoechea and Daan Frenkel (pp. 10963–10968) use mathematical analysis and computer simulations to explain concentration-based binding in particles coated with one type or multiple types of binding molecules. The authors found that single-binding particles are not highly sensitive to the concentration of receptors covering a surface. Multiple-binding particles behave differently, the researchers report. These particles display regimes of "super selectivity," in which the fraction of bound particles varies sharply with receptor concentration. Selectivity is highest when the particles are only weakly attracted to the surface, the authors found. If binding is strong, however, particles will attach to the surface regardless of the concentration of attractants. The analyses help to explain the perplexing results of previous particle binding experiments, according to the authors. Based on the results, the researchers suggest design rules for particles that display "on-off" binding behavior based on the concentration of receptors on a given surface. — J.M.



Super selectivity: surface receptors (red), multivalent particles (green), and binding molecules (blue).

A potential neural basis for impulsiveness

Like wisdom, self control is often thought to increase with advancing age, but a pathological loss of self control can lead to a tendency for criminality. To uncover a neural basis for impulsiveness, Benjamin Shannon et al. (pp. 11241–11245) performed an fMRI experiment aimed at comparing the brain's functional connectivity in more than 100 juvenile offenders at a high-security facility and typically developing individuals ranging in age from 7–31 years. The authors scanned the brains of the participants as they rested quietly. In less impulsive juvenile offenders, the authors report, activity in brain regions involved in planning movements, dubbed "motor planning regions," mirrored activity in regions involved in attention and cognitive control. In contrast, in more impulsive offenders, activity in motor planning regions was correlated with activity in a brain network involved in spontaneous, unconstrained cognition, called the "default mode" network. Among typically developing individuals, the patterns of activity in motor planning regions varied with age: Brain activity in younger individuals resembled that observed in more impulsive offenders, whereas activity in older individuals resembled that seen in less impulsive offenders. The authors suggest that their findings not only help explain why the actions of impulsive people might be driven by instant gratification rather than by long-term consequences but also suggest that impulsiveness among juvenile offenders might represent a developmental delay. — P.N.



Low (blue) and high (yellow) motor planning connectivity in typical adults.