CLIMATE SCIENCE

The Shape They’re In

Soot, the product of the incomplete combustion of fossil fuels and biomass, is emitted in large quantities globally and is one of the more important climate-forcing agents added to the atmosphere. The radiative and chemical properties of soot particles depend largely on their shape, which generally is not well defined and hence is usually modeled as a sphere or an elongated cylinder.

In order to characterize the actual morphology of soot, van Poppel et al. have used electron tomography to determine shapes, volumes, and surface areas of clusters of soot nanoparticles. They find that the imaged surface areas and volumes can differ from the geometrically modeled values by one and two orders of magnitude, respectively. This result has important implications for the chemical aging of soot—the process of changing hydrophobic soot particles into a hydrophilic and more readily scavenged aerosol—which affects its atmospheric lifetime and its radiative forcing potency. – HJS


BIO MATERIALS

A Degrading Approach

Biocompatible scaffolds are used to enhance cell survival and to improve the integration of tissues grown ex vivo and for in vivo implantation. As cells respond to external cues and require nutrients for growth, an ideal environment should be able to adjust dynamically in accordance with their needs.

Mahoney and Anseth have designed a series of polyethylene glycol (PEG) hydrogels in which the cross-links hydrolyze slowly; thus the mesh size increases over several weeks. Neural precursor cells were encapsulated in the hydrogels and followed with confocal microscopy. Cells cultured within this three-dimensional environment grew to form microtissues and were able to proliferate and differentiate into neurons and glial cells. When exposed to the neurotransmitter γ-aminobutyric acid, calcium transients were observed in cells in the interior and exterior of the microtissues and in cell processes. The mechanical strength of the gels is such that they are suitable for injection into tissue, and by changing the degradation rate of the linker, the authors could alter the time scale for neural cell extension from 1 to 3 weeks. – MSL


PSYCHOLOGY

Asian/American Views

There is ample evidence that people in different cultures can exhibit dissimilar ways of thinking. For instance, Asians pay more attention to context and to the relationships between focal (foreground) objects and background in their descriptions of visual scenes, whereas Americans mention the focal items with greater frequency. Why this occurs is unclear, as is the cognitive source of the differences in behavior.

Miyamoto et al. present a set of studies that begin to identify the underlying processes and how the physical environment may serve to reinforce cultural distinctions. They presented Japanese and American study participants with photographs taken of hotels, schools, and post offices located in large, medium, and small cities in Japan and the United States. People of both nationalities rated the scenes of Japan as being more complicated (more objects, more chaotic, more obscured parts); although the U.S. scenes increased in complexity with city size, the Japanese scenes did not and were all more complex than those from the large U.S. city (New York). A similar ranking was obtained by analyzing the photos with the NIH Image program. In order to assess the influence of complexity on behavior, both nationalities were tested for their ability to detect changes in focal objects and background information in neutral vignettes after having been primed with the photos of Japan or the United States. Having first viewed a more complex scene improved the abilities of both the American and Japanese participants in reporting contextual, as opposed to focal, changes. – GJC


GENETICS

The Grandmother Effect

Women’s postreproductive years, the immaturity of newborns, and strong kinship networks combine to make it reasonable that the grandmother effect could be important in the evolution of human life-span structure. For guppies, on the other hand, with live-born young that require no further care and with a lack of familial structures, the female postreproductive life phase is not likely to be a target of evolutionary forces. In fact, because guppies produce eggs throughout adulthood, a nonreproductive late-adult phase seems unlikely.

Nonetheless, guppies do have a postreproductive life phase, and, as Reznick et al. show, this phase seems to be an accident of extended reproductive life span rather than a point of evolutionary leverage. Guppies that face high rates of predation mature earlier and...
Coping Well with Crowding

Perylene bisimides, which are highly efficient and tunable fluorophores, are linear molecules with two imide groups (-CONRCO-) straddling the naphthalenic ends. Ilhan et al. report the synthesis of “Z-shaped” analogs in which the imide groups attach symmetrically but to only one aromatic ring each on opposite sides of the molecule, through the Diels-Alder trapping of a diketone-substituted anthracene with N-octylmaleimide, which produces α-xylylenols. Subsequent dehydration and aromatization steps yielded the Z-shaped bisimides; the more crowded substitution pattern as compared to the linear isomers causes twisting of the perylene core. Despite this twisting, the absorption and emission spectra show only a slight blue shift. This route should allow the synthesis of other perylene bisimides substituted at the imide and phenyl positions. – PDS


Localized Therapy

The past two decades have brought remarkable progress in the development of more effective chemotherapy drugs for breast cancer. Unfortunately, many of these drugs produce undesirable side effects, largely because they are delivered systemically—to vulnerable normal tissue as well as to the intended tumor target. The mammary gland provides an alternative route for tumor access: the mammary ductal networks that terminate at the nipple. Indeed, the vast majority of human breast cancers arise in the epithelial lining of these ducts.

Studying two rodent models, Murata et al. investigated whether mammary tumors could be prevented and treated by injection of chemotherapeutic drugs directly into the mammary ducts, a strategy that in principle would maximize drug concentrations around the pre-malignant and malignant cells, while sparing normal tissue. Intraductal delivery of derivatives of tamoxifen or doxorubicin—two of the most commonly used drugs for human breast cancer—was found to be equal or superior to intravenous delivery in suppressing tumor growth, and there was no evidence of systemic toxicity. Because the mammary ducts of rodents and humans are anatomically distinct, it is unclear whether a similar drug delivery protocol would be effective clinically, but these promising results should stimulate further work in this direction. – PAK


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spin-polarized injection efficiency, which has been demonstrated in several practical structures such as ferromagnet/oxide/ferromagnet spin filters and ferromagnet/oxide/semiconductor systems. However, polarized photoluminescence from a semiconductor quantum well, a technique routinely used to determine the extent of the spin polarization and spin injection efficiency, usually exhibits somewhat complex behavior in terms of temperature dependence.

Salis et al. report that the spin injection efficiency from CoFe/MgO electrodes is around 70% and is actually independent of temperature from 10 K all the way up to room temperature. The temperature dependence of the photoluminescence arises from the temperature dependence of the carrier recombination rate in the quantum well itself, a result that bodes well for the application of such spin-injecting electrodes in other spintronic devices. – ISO


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reproduce more often than guppies in more benign bends of the river. When reared in the lab, safe from predators, these two populations continued to show different life histories, and the predator-intense family of guppies lived longer. Many of these individuals had a postreproductive life phase, suggesting that reproductive senescence precedes somatic senescence. The length of the postreproductive life phase seemed to be an accidental outcome of the generally longer reproductive life span that the high-predation environment had brought about. – PJH

The Grandmother Effect
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