**GEOL OGY**

**Diamond Diversity**

The chemistry of diamonds brought up from Earth’s mantle—notably their widely ranging nitrogen contents and nitrogen and carbon isotope values—has complicated understanding of their origins. It is commonly thought that many diamonds form from the movement of carbon-rich fluids into deep mantle rocks of a contrasting composition, thereby inducing diamond precipitation. To better constrain these fluids and sources, Thomassot et al. studied in detail nearly 60 diamonds contained within one small (<30 cm$^3$) mantle sample carried to the surface in a kimberlite volcano in South Africa. Surprisingly, the nitrogen contents and isotopic values of these diamonds in one this one sample spanned a large part of the ranges observed from all diamonds worldwide. The covariances of the data imply that these diamonds formed from a methane-rich fluid, not a more oxidized fluid as commonly assumed. The wide variation can be produced by the fractionation of nitrogen and carbon during growth of the diamonds over time. Such fluids may also account for the variable oxidation state of the mantle beneath Earth’s most ancient crust. — BH


**B I O C H E M I S T R Y**

**Activating En Passant**

Autotransporters are a family of bacterial virulence proteins that are first translocated across the inner membrane and then inserted into the outer membrane. The smaller C-terminal domain adopts a β barrel structure that spans the outer membrane and serves as a transitway for the larger N-terminal “passenger” domain, which is transported through the barrel; some passenger domains are released into the extracellular space by proteolysis.

In an extensive series of genetic and biochemical experiments, Dautin et al. show that the passenger domain of _Escherichia coli_ autotransporter EspP is cleaved in an unusual fashion: not by a periplasmic or outer membrane protease, but by itself. Enzymatic hydrolysis of a peptide bond is customarily initiated by an activated nucleophile. Like the classical serine protease catalytic triad, where the carbonylate of an aspartate residue pulls on the hydroxyl proton of the active-site serine (via an intermediary histidine), EspP also uses an aspartate, which happens to reside on the inner surface of the β barrel and is located roughly halfway across the thickness of the outer membrane. This carbonylate pulls on the amide proton of an asparagine residue in the transiting passenger domain; this activates the amide nitrogen for attack on and cleavage of the peptide backbone, yielding a succinimide that could be resolved as a mixture of asparagine and isoasparagine. This asparagine-aspartate self-cleaving mechanism appears to be utilized by other autotransporters as well as by eukaryotic viruses during capsid maturation.—GJC


**MICROB I O L OGY**

**At the Point of Attack**

Tuberculosis kills approximately 3 million people each year. The pathogenic agent _Mycobacterium tuberculosis_ invades and replicates within macrophages, constructing for itself an intracellular vacuole that shelters it from immune surveillance and attack. Alteri et al. have investigated how _M. tuberculosis_ binds to and invades potential host cells. On the surface of the microbe, they discovered fine fibers, referred to as pili, that are 2 to 3 nm wide and are likely to be important in enabling the microbe to adhere to target cells. They isolated the pili and have characterized their composition using mass spectrometry and immunochemistry. The pili are assembled from low-molecular-weight protein subunits; these bind to the protein laminin, which is an abundant component of the extracellular matrix within human tissues. Furthermore, the sera of tuberculosis patients contained antibodies that recognized the pilin subunit. The unanticipated identification of what may represent a key protein in the early stages of host colonization by _M. tuberculosis_ may lead to the development of new therapies and vaccines. —SMH


**C H E M I S T R Y**

**Sorting Storage Options**

In the search for a practical mode of hydrogen storage for vehicle applications, light metal hydride compounds such as LiBH$_4$ are appealing because of their high weight percentage of hydrogen. However, many such compounds are thermodynamically quite stable, and so require excessive heating to liberate H$_2$. One means of addressing this problem is to mix together two or more hydride compounds which, on releasing hydrogen, can form a stable co-product that drives the reaction—MgH$_2$, for example, reacts with LiBH$_4$ to yield MgB$_2$. Alapati et al. have used plane wave density functional theory in an effort to narrow the dauntingly large range of potential compound combinations worth exploring in this vein. Specifically, they performed a rough energy calculation of 152 known light metal solids and used the results to screen more than
Natural Sunblock

Before the health hazards of ultraviolet (UV) light exposure were fully appreciated, sun worshippers applied lotions hoping to tan rather than burn. Skin tanning results from the production of the pigment melanin, which absorbs UV radiation and can partially protect cells from the UV-induced DNA damage that can ultimately cause skin cancer. Without melanin, cells are highly susceptible to sunlight; sunburn is the body’s response to this damage.

Cui et al. show that the tumor suppressor p53, which functions as a transcription factor and is one of the most intensely studied proteins in biology, plays a crucial role in UV-induced melanin production. Studying p53-deficient mice as well as normal human skin samples, they find that UV light activates p53 in skin keratinocytes (the outermost cells) and that p53 activates the gene encoding pro-opiomelanocortin (POMC). The POMC protein is then cut in several places to generate peptides, including α-melanocyte-stimulating hormone, which stimulates melanocytes (cells located at the base of the epidermis) to produce melanin. Interestingly, POMC proteolysis also generates the opioid peptide β-endorphin, which the authors speculate might contribute to sun-seeking behavior in humans. — PAK


A Swell Stopper

In rotaxane molecules, macrocycles are held onto rodlike cores by bulky end groups that effectively act as stoppers. Rotaxane synthesis usually requires first threading an open-ended rod through the cycle, followed by the addition of a third molecule to the free end of the rod in order to form the second stopper. Chiu et al. present a two-component system in which an enyl-2-vinylcyclopropane end group of the rodlike molecule “swells” after the macrocycle has been threaded. A Cope rearrangement that is slow at room temperature occurs after 2 days of heating at 50°C, creating a bulky cycloheptadiene capping group. Hydrogenation of the racemic product mixture yields a single saturated isomer for the rodlike molecule. The authors demonstrate the technique with two different macrocycles, confirming by nuclear magnetic resonance spectroscopy that the rods and rings successfully interlock. — PDS


An Empathy Block

Everyday experience confirms the general belief that humans are social animals; the neural pathways subserving prosocial behaviors are a subject of current research, and the evolutionary origins of these behaviors are hotly debated. Although there is evidence that social exclusion can elicit redoubled efforts to develop social connections, the consequences of exclusion are predominantly negative—feeling hurt, acting belligerently, or adopting a lone-wolf lifestyle—and Twenge et al. have begun to examine what might mediate these apparently atypical responses.

Using a variety of experimental contexts (such as the canonical spilled-pencils incident) and measures (such as donations of money or cooperation in a prisoner’s dilemma game), they find that being characterized as having a high likelihood of a prosocial lifestyle with many strong relationships, such as marriage, resulted in participants helping to pick up pencils (on average, 8 out of 20 spilled) versus the performance of those labeled as being apt to lead solitary lives (less than 1 pencil picked up). As to what factors mediate the extent (or absence) of prosocial behavior, some of the likely candidates (trusting the other or having a sense of belonging) did not register, whereas empathic concern did. Combining this finding with an earlier one, which showed that social exclusion activates the neural circuits encoding pain, produces the speculation that an after-effect of rejection is an emotional numbness or an inability to mirror the affective states of others. — GJC


From life on Mars to life sciences

For careers in science, turn to Science

If you want your career to skyrocket, visit ScienceCareers.org. We are committed to helping you find the right job, and delivering useful advice. Our knowledge is firmly founded on the expertise of Science, and the long experience of AAAS in advancing science around the world. ScienceCareers.org is the natural selection.

www.sciencecareers.org

Features include:
• Thousands of job postings
• Career tools from Next Wave
• Grant information
• Resume/CV Database
• Career Forum