tion between pairs of brains was still close to 25% of the cortical surface.

The investigators also confirmed that a region in the fusiform gyrus, which is known to respond strongly to faces, showed similar robust responses during (unconstrained) viewing of the movie. Likewise, a region in the collateral sulcus produced vigorous responses when subjects viewed images of indoor and outdoor scenes, including buildings. In fMRI analysis, experimenters typically use the sequence of stimulation (which is known in advance) to predict the response. However, because of the unconstrained nature of the movie visual stimulus, Hasson *et al.* had to resort to a different strategy. They inverted the usual analysis process and used the signal amplitude at a given location to predict which type of stimulus was effective in eliciting a response. By doing so, they could construct a "movie" that was based on the edited sequence of all movie frames that evoked strong activation. Hence, they could determine, for example, that the fusiform gyrus responded strongly to close-ups of face images during the movie. Hasson *et al.*'s study is important, then, because it shows that the response properties observed in previous fMRI studies, which were based on controlled experimental situations, are valid for situations that are closer to real life [see (*10*, *11*) for fMRI studies using less constrained situations].

Perhaps just as important as Hasson *et al.*'s findings about interbrain correlations is their observation that large regions of activated cortex could not be predicted from another individual's brain activity. These regions include portions of the parietal cortex and, notably, the majority of the prefrontal cortex. Thus, there might be, after all, ample cortex for you and I to experience *The Good, the Bad, and the Ugly* in a unique way. It also means that there is enough work to keep neuroscientists busy for quite some time.

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GEOCHEMISTRY

What Biogenic Minerals Tell Us

Danielle Fortin

Biogenic minerals are generally those formed in the presence of biological cells (mainly bacteria; see the figure) and structures outside cells (*1*). These minerals, which come in a variety of types and shapes, are often small (on the order of nanometers) and occur in close association with the bacterial cell wall. Several studies (*2*–*7*) have shown such an association in natural samples taken from a wide range of environments, as well as in synthetic samples produced under laboratory conditions that mimic natural conditions. Some studies have also reported the formation of biogenic minerals inside microbial cells (*8*, *9*). Although the occurrence of biogenic minerals in natural environments is well documented, the exact formation mechanisms are still poorly understood. A clear understanding of these mechanisms is essential in order to assess how bacteria interact with metals in present and ancient environments. In addition, a clear demonstration that bacteria can template mineral crystallization is also crucial because it might lead to the development of new tools in the search for evidence of past life on Earth and other planets.

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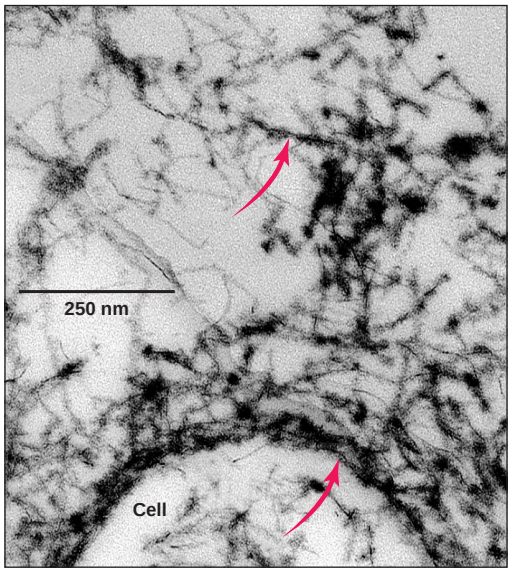
Many researchers accept that bacteria can trigger mineral formation under saturation conditions through active reactions (from physiological and metabolic activity) and passive reactions (from surface reactivity of the cell wall or extracellular structures such as exopolymers) (*1*), but the reasons why bacteria favor or promote mineral nucleation are still unclear. One general explanation is that bacteria do so to prevent cell entombment and death by mineral metabolic by-products. Even though the survival of microbial cells is a logical explanation, an alternative is reported on page 1656 of this issue by Chan *et al.* (*10*). These authors propose that neutrophilic iron-oxidizing bacteria promote the formation of elongated iron oxide minerals (identified as akaganeite) onto extracellular polymers (polysaccharides) in order to enhance metabolic energy generation.

Chan *et al.* analyzed natural biominerals in an iron oxide–encrusted biofilm collected in a flooded mine. With the help of high-resolution synchrotron spectromicroscopy [x-ray photoemission electron microscopy (X-PEEM) and x-ray absorption near-edge structure (XANES)] and high-resolution transmission electron microscopy (HRTEM), they were able to show that microbially produced polysaccharides can template the nucleation of pseudo–single crystals (that is, having the appearance of single crystal structure) of akaganeite (with aspect ratios of about 1000:1). Unlike previous electron microscopy studies that showed bacteria-mineral associations and concluded that bacteria were likely involved in mineral formation (*2*, *3*, *5*, *7*), the study by Chan *et al.*



Bacterial oxides. Transmission electron microscopy (TEM) image shows natural bacterial exopolymers covered with poorly ordered iron oxides. The sample was collected in the oxic sediments of a neutral-pH freshwater lake. The arrows indicate the position of very thin crystals of iron oxides on the cell wall and within the extracellular exopolymers. The elongated fine crystals appear to be covered by a more amorphous form of iron oxide.

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clearly shows the presence of a microbially derived organic-rich template for iron oxide formation. The clever use of carbon K-edge XANES analysis indicates a strong similarity between the spectra of synthetic acidic polysaccharides and the natural mineralized filaments.

The authors were also able to reproduce the formation of iron-rich filaments and elongated akaganeite crystals under laboratory conditions. Scanning transmission x-ray microscopy (STXM) and spectral analyses confirmed the presence of mineralized filaments rich in iron and carbon in an alginate solution mixed with ferric iron. Additional syntheses with a mixture of polysaccharides rich in carboxylic groups revealed the presence of elongated akaganeite crystals with smaller aspect ratios than those found in the natural sample. The combination of high-quality HRTEM images and XANES analysis provides compelling evidence that organic exopolymers secreted by bacterial cells can indeed template the crystallization of iron oxides. As stated by the authors, the use of high spatial resolution tools and powerful mineralogical analysis to characterize samples containing mineralized organic structures should improve our understanding of biomineralization mechanisms.

Chan *et al*. also propose a novel mechanism for the formation of crystals on bacterial exopolymers. They hypothesize that the oxidation of ferrous iron by iron-oxidizing bacteria increases the pH gradient across the cell membrane. The generation of protons near the cell wall is then thought to enhance the proton motive force and thus increase the energy-generating potential of the cell. This interesting hypothesis raises the possibility that bacteria do profit from encrusting themselves with various minerals (especially precipitation reactions leading to a pH gradient) because it allows them not only to survive, but also to gain useful energy in sometimes hostile or extreme environments.

Finally, a better understanding of the mechanisms leading to crystal nucleation on organic templates in natural environments and better characterization of such minerals might allow us to identify specific characteristics unique to biogenic minerals. Such characteristics could then become very helpful in the search for biosignatures in ancient environments on Earth and other planets. This is especially important for the NASA astrobiology program, which aims to learn how to recognize signatures of life on other worlds (*11*). The present and upcoming missions to Mars have already generated a lot of interest among the general public and in the scientific community. With more research such as that of Chan *et al*. (*10*), we may soon be able to ascertain whether life existed or still exists on other worlds. But with the lessons learned from the famous Martian meteorite (*12*), we must keep in mind that it is difficult to differentiate between biotic and abiotic mechanisms. With care, it should be possible to distinguish one from the other and apply our newly gained knowledge to samples returned from Mars or other planets.

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NEUROSCIENCE

Blocking Plasticity in the Visual Cortex

David Ferster

Few scientific questions strike as close to our hearts as the debate over nature versus nurture. Are human behavior and personality shaped by genes or by early experience? There is strong evidence that they are shaped by both. Single genetic mutations can profoundly affect complex behaviors such as sleep-wake cycles (*1*), parental care (*2*), and memory (*3*). Yet early experience can permanently alter adult behavior through its effect on development. In Harlow's classic experiments, for example, monkeys raised with inanimate objects as surrogate mothers suffered from social deficits later in life (*4*). One of the central pursuits of neuroscience, therefore, is to uncover the cellular and molecular mechanisms by which early experience alters brain development. Yet we have little idea where "mothering" and "social interaction" are generated in the brain, let alone how one might influence the other. To study the effects of early experience, neuroscientists have turned to model systems in which early experience is easy to manipulate and the resulting neural changes are easy to measure. The most intensely studied model of environmentally driven neural plasticity is that of ocular dominance columns in the developing mammalian visual cortex (*5*). In this issue, two studies—by Hensch and Stryker on page 1678 (*6*) and by Fagiolini *et al*. on page 1681 (*7*)—provide major insights into the activity-driven adaptation of the mammalian visual cortex to incoming visual stimuli during early postnatal life.

In the adult brain of many mammalian species, synaptic inputs from thalamic relay cells driven by one eye are clustered in the visual cortex into nearly parallel, stripelike regions or columns ~0.5 mm wide, which alternate with columns dominated by the other eye. At birth, however, thalamic inputs to the visual cortex from the two eyes start out completely overlapping with each other and segregate themselves into stripelike ocular dominance bands over the course of the next several weeks. This segregation process is exquisitely sensitive to visual experience: When vision in one eye is degraded during development (by surgically closing that eye), the ocular dominance bands for that eye narrow, and those for the normal eye broaden, so that the normal eye ends up with a much larger fraction of the cortical area. These changes become irreversible with the end of the early critical period (which, in kittens, is about 12 weeks after birth). Eye closure after the critical period has no effect on column width.

What drives apart the initially overlapping thalamic inputs from the two eyes, and what determines the pattern of segregation? Why stripes and not checkerboards? Why 0.5 mm? One possibility is that the inputs are guided by unknown molecular cues that differentially attract inputs from the two eyes. These cues could be arranged in preexisting stripelike patterns within the visual cortex (*8*), and

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