## << Don’t Cross the Border!

At least three cell types are thought to encode an animal’s position in the environment: place cells, whose activity indicates a particular location in space, head direction cells, which fire only when the animal is facing a certain direction, and grid cells, whose firing fields form a regular pattern across the environment. However, computational models suggested the existence of at least one more cell type called “boundary vector cells” whose activity patterns encode an animal’s distance, in a certain direction, from a salient geometrical border. Now **Solstad *et al.*** (p. 1865) provide experimental evidence for a cell type in the spatial representation circuit of the medial entorhinal cortex, termed the border cell, that fits the bill. Border cells have firing fields that line up along selected geometric boundaries of the proximal environment, irrespective of boundary length or continuity with other boundaries. Collectively, border cells may thus perhaps define the perimeter of the environment and thereby serve as a reference frame for places inside it, controlling the activity of the other position-sensing cell types in that environment.

## Cellular Reprogramming

After fertilization of the egg its daughter cells progress through embryonic, fetal, and adult stages, taking various pathways to specify the myriad differentiated cell types of an organism. Although these pathways are generally viewed as one-way and irreversible, recent studies report “reprogramming” methods by which a cell is converted to another cell type. **Gurdon and Melton** (p. 1811) review the history and lay out the current understanding of, and future prospects for, cellular reprogramming as seen in somatic cell nuclear transfer, cell fusion, the generation of induced pluripotent cells, and direct cellular reprogramming.

## Glass in the Making

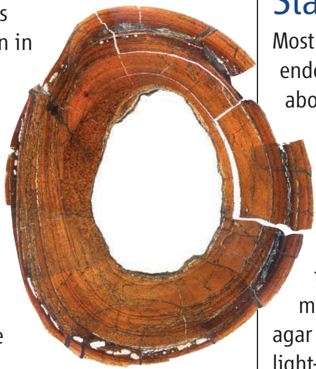
A challenge to identifying materials that will form glassy solids is to find properties in the melt state that would indicate that the material will not crystallize on cooling. **Li *et al.*** (p. 1816) describe a method to measure the density changes during crystallization in thin films for a range of copper-zirconium alloys and compare these findings with the maxima in the critical thickness for forming a glass via rapid quenching. A match between the peaks in density and glass-forming ability was observed. The finding of three sets of matching peaks conflicts with existing models on glass formation, which can only account for one set of matching peaks.

## Pre-Crystal Clusters

It is very hard to study the earliest stages of crystallization, when nuclei form from the stable clustering of a sufficient number of atoms, molecules or ions. **Gebauer *et al.*** (p. 1819; see the Perspective by **Meldrum and Sear**) present data that imply that calcium carbonate forms stable neutral ion clusters prior to nucleation. These clusters form prior to the formation of an amorphous calcium carbonate phase, which had been thought of as the precursor material used by organisms to grow large, complex single crystals. These findings have implications not only for the understanding of the crystallization of calcium carbonate, but also for the better understanding of the mass transport of calcium carbonate in the formation of scales, biological deposits, and sediments.

## Paternal Parenting

Paternal care of eggs and hatchlings is a common feature of birds. This breeding system has not been thought of as being of ancient origin in birds, but instead has been thought to be a derived feature. However, **Varricchio *et al.*** (p. 1826; see the Perspective by **Prum**) present data that support the hypothesis that this breeding system arose in theropod dinosaur ancestors of birds, before the origin of birds and flight. Fossil data on clutch sizes and bone histology show that several groups of Cretaceous dinosaurs share features in common with modern birds that use male-only care systems, suggesting that paternal care has a deep evolutionary history in the vertebrate phylum.



## Martian Minerals

Most orbital and rover data has indicated that early Mars’ was a fairly acidic environment; large areas of carbonate minerals have not been found in either the older or younger terrains. **Ehlmann *et al.*** (p. 1828) now report the detection of some carbonate minerals using a spectrometer on the Mars Reconnaissance Orbiter. The carbonate minerals are closely associated with abundant clay minerals in this area, implying that weathering of the crust here was by neutral or alkaline waters and that any later alterations by acidic weathering were insufficient to dissolve the carbonate minerals.

## Slave to the Rhythm

Most organisms, from bacteria to humans, harbor endogenous clocks that cycle with a period of about 24 hours. These clocks function within individual cells and comprise regulatory feedback loops of transcriptional and post-translational processes. Plants are thought to use a circadian clock consisting of three light-sensitive, interlocked transcription-translation feedback loops. Because experiments have generally used plants grown on agar plates—where the roots are exposed to light—the fact that a different circadian clock operates in plant roots has been obscured. By growing plants hydroponically with the roots in darkness, **James *et al.*** (p. 1832) discovered that

*Continued on page 1755*

CREDITS (TOP TO BOTTOM): RAYMOND SKJERPENG/NOWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY; DAVID VARRICCHIO


Published by AAAS

*Continued from page 1753*

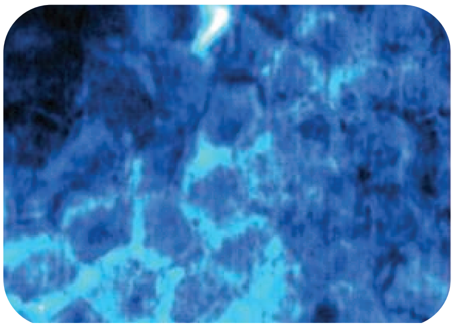
the root circadian clock is a stripped down version of the clock that operates in the shoots, operating on only one of the feedback loops and regulating only a small number of genes. In roots, two of the feedback loops are inactivated in that two clock components (CCA1 and LHY) do not regulate gene expression like they do in shoots. However, the shoot and root clocks are synchronized under normal day/night conditions, possibly by circulating metabolic signals, making the root clock essentially a "slave" to the shoot clock.

## Leaf-Shape Control

Each plant leaf emerges from a single primordium, but the shape of the resulting leaves can range from a simple oval to a complex formation of subdivisions—leaflets, with edges that can be lobed or serrated. **Blein *et al.*** (p. 1835) looked at the molecular controls guiding leaf development. The NAM/CUC (NO APICAL MERISTEM/CUP-SHAPED COTYLEDON) genes, which function as transcription factors involved in establishing boundaries, were cloned from a variety of plants and their expression patterns manipulated. Across a wide range of different plants, localized expression of the NAM/CUC genes in leaflet primordia was required for the formation of subdivided leaves, and reductions in these boundary gene expression levels generated fewer and fused leaflets.

## Forever Young?

Gamma-globin, a constituent of fetal hemoglobin, is normally expressed during fetal development. After birth, fetal hemoglobin expression is down-regulated when expression of the adult variant, β-globin, rises. Reliance of the adult on β-globin is not a problem, unless genetic defects disrupt the structure or function of β-globin, as is the case with some thalassemias and with sickle cell anemia. In such cases, the fetal variant, γ-globin, could potentially function as a replacement, except the γ-globin gene has usually been turned off by the process of globin gene switching. **Sankaran *et al.*** (p. 1839, published online 4 December; see the Perspective by **Michelson**) now show that the *BCL11A* gene, which encodes a putative transcription factor implicated in globin gene control, seems to function as a repressor of γ-globin gene expression. Use of small RNAs to knock down *BCL11A* expression in cultured erythroid cells resulted in increased γ-globin expression. Thus, *BCL11A* represents a target for interventions to treat sickle cell anemia and some thalassemias.



## Looking at Lipids

A method for label-free microscopy of fatty acids, drugs, and metabolites in live cells and tissues would be useful for a variety of biomedical, developmental, and cell biological studies. Characteristic Raman scattering frequencies provide signatures for various chemical bonds; however, imaging methods based on Raman scattering have been limited by low sensitivity and high nonresonant backgrounds. **Freudiger *et al.*** (p. 1857) now report a three-dimensional imaging technique based on stimulated Raman scattering that achieves background-free chemical contrast with relatively high sensitivity. They apply the method to image lipids in living cells and tissues, and to monitor drug delivery through the epidermis.

## Unhealthy Competition

Hematopoietic progenitor cells (HPCs), the cells that ensure the body is supplied with healthy blood cells throughout life, reside within a specific bone marrow microenvironment, or "niche," that regulates their survival, growth, and differentiation. **Colmone *et al.*** (p. 1861) explored the impact of leukemia on normal HPC niches by applying real-time in vivo imaging methods to mouse leukemia models. Leukemic cells were found to create a malignant niche that out-competes normal niches in attracting HPCs. This competition leads both to a reduction in the number of HPCs and to disruption of HPC function, as evidenced by failure of the cells to mobilize into the circulation in response to cytokine stimulation. These effects were mediated in part by stem cell factor, a chemoattractant secreted by the leukemic cells. Thus, therapeutic inhibition of stem cell factor may be a valuable way to increase hematopoietic reserves in patients with leukemia.

CREDIT: FREUDIGER *ET AL.*





*Published by AAAS*