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ECOLOGY

Getting It Just Right

North American monarch butterflies are known for the massive southern migrations they undertake each year. During these migrations, a single butterfly may fly over 2500 miles south to the overwintering site, where it enters diapause, a hibernation-like state. This same butterfly will then fly northward in the spring, where it will become reproductive before dying and leaving the remainder of the return trip to its offspring. Monarchs coordinate their southward flight on the basis of a Sun compass mediated through circadian clocks located in the antennae. Guerra and Reppert now show that northbound flight is mediated by the same Sun compass mechanism. This finding begs the question, however, of how individuals are able to "switch" their compasses to fly south in the fall and north in the spring. Exposure of fall remigrants to variations of the day length and temperature conditions encountered at overwintering sites revealed that although day length has no effect on flight direction, temperature was able to facilitate the directional switch. Specifically, butterflies exposed to temperatures that were too warm did not switch their flight directions, whereas those exposed to appropriately cold temperatures flew north as expected. Thus, cold temperatures during overwintering are necessary for the completion of the enigmatic migration. Furthermore, warmer winters at these sites, due to climate change, may interfere with the monarch's migration home. — SNV

Curr. Biol. 10.1016/j.cub.2013.01.052 (2013).

SIGNAL TRANSDUCTION

Transcription Takes a Back Seat

When a bacterial cell responds to environmental changes in carbon sources available as food, how would you say this occurs—through changes in gene expression directed by appropriate transcription factors, perhaps? Berthoumieux *et al.* show that this seemingly likely scenario actually accounted for little of the response of *Escherichia coli* to nutritional stress. Rather, it was the "physiological state of the cell" that coordinated the gene expression program. That is, it was not the binding of transcription factors to particular target genes that produced the changes in gene expression in the bacteria, but instead global changes in transcription and translation mediated by changes, for example, in the abundance of RNA polymerase, ribosomes, and the pools of available amino acids and nucleotides. Mathematical modeling used to measure the relative contributions of specific transcriptional control and global changes in physiological state showed the primary mechanism to be the latter, which ironically is almost never accounted for in diagrams of cellular regulatory networks. — LBR

Mol. Syst. Biol. **9**, 634 (2013).

SIGNAL TRANSDUCTION

See-Saw Gene Expression

Upon wounding, the body must act quickly to initiate a repair or regeneration response. Using a human-skin ex vivo organ-culture system, Sundaram *et al.* found that the small noncoding RNA miR-198, which is encoded in the 3′ untranslated region of follistatin-like 1 (FSTL1), is expressed at high levels in healthy epidermis but is suppressed after wounding. FSTL1 showed the opposite pattern of expression. Knockdown studies demonstrated that FSTL1 promoted keratinocyte migration, which is important for wound healing, whereas miR-198 suppressed this. Examination of chronic nonhealing ulcer wounds from individuals with diabetes mellitus revealed that miR-198 rather than FSTL1 was expressed, which explains the lack of keratinocyte migration and tissue repair seen in these lesions. A posttranscriptional regulatory mechanism allows for this "see-saw" pattern of expression: Transforming growth factor-1 helped to stabilize FSTL1 by down-regulating the splicing regulatory protein KSRP, which is necessary for miR-198 expression. — BAP

Nature 10.1038/nature11890 (2013).

MATERIALS SCIENCE

Welded Together

Welding depends on a strong bond forming between two pieces that have been heated to the point where they partially melt at the area that is being fused together. In joining two polymer pieces together, it was thought that the welded area would attain the same strength as the bulk material when the polymer chains had diffused by a distance close to their radius of gyration, but experimentally, bulk strength has been obtained in much shorter times. Ge *et al.* use molecular dynamics simulations to probe the weld region between two homopolymer segments in order to determine the correlation between individual chain motion and the shear strength of the welded pieces. At short weld times, the dominant failure mode is caused by the pullout of individual chains at the interface. Then there is a transition, once the interface chains are sufficiently embedded and entangled into the opposite region, where chain pullout decreases and bond breaking occurs. At first, this chain scission occurs primarily at the interface region, but then evolves so that bonds break uniformly across the specimen, showing that the welded region has achieved the bulk strength. This corresponds to when the areal density of entanglements matches the bulk value, and confirms that this is the key parameter to determining the time needed to achieve a strong weld. — MSL

Phys. Rev. Lett. **110**, 098301 (2013).

BIOMEDICINE

RAS Helping RAS

Solid tumors contain not only malignant cells but also a wide array of host-derived cells that can have dramatic effects on tumor behavior. These include macrophages, immune cells that enhance tumor progression in part by promoting inflammation and whose presence in tumors

Continued on page 1255

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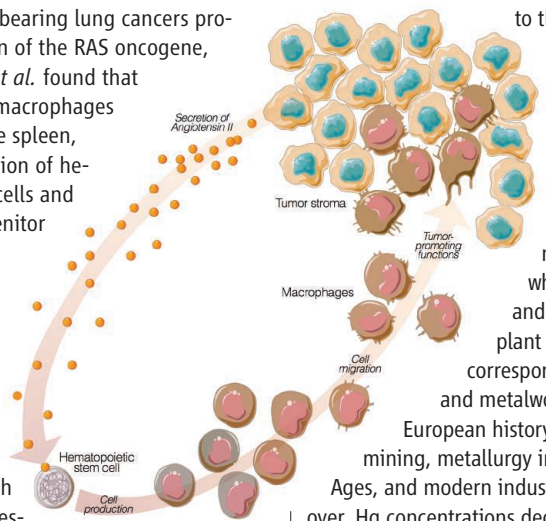
correlates with reduced patient survival times. Macrophages must be continually replenished as the tumor grows, but little is known about this replenishment process.

Studying mice bearing lung cancers produced by activation of the RAS oncogene, Cortez-Retamozo *et al.* found that tumor-associated macrophages are supplied by the spleen, through amplification of hematopoietic stem cells and macrophage progenitor cells. This cell amplification process was stimulated by angiotensin II, a peptide hormone better known for its role in the renin-angiotensin system (RAS), which regulates blood pressure. Notably, mice treated with the blood pressure medication enalapril, which inhibits angiotensin II production, had fewer tumor-associated macrophages and fewer lung tumor nodules than control mice. Whether these results can be extrapolated to human lung cancer remains to be determined. — PAK



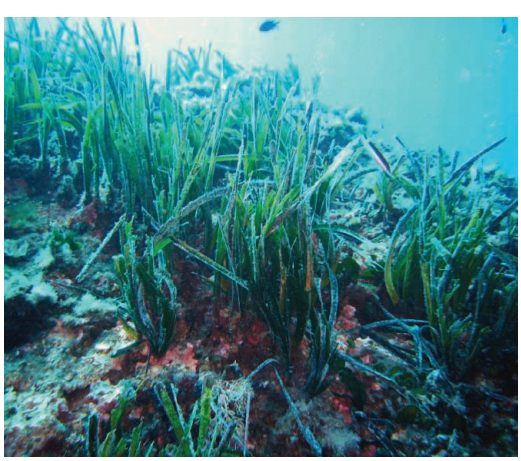
Immunity **38**, 296 (2013).

GEOCHEMISTRY

Mercury Gas in Neptune Grass

Not far off the coast of the Mediterranean Sea, meadows of the flowering seagrass *Posidonia oceanica*, or Neptune grass, cover the seafloor. The vast network of ancient mat deposits in the sediments in and below the root layer preserve a rich record of the water chemistry over thousands of years. Serrano *et al.* show that a Neptune grass mat deposit in a bay off the northeast coast of the Iberian Peninsula—a region with a complex legacy of mercury (Hg) mining activities—preserves a ~2500-year record of anthropogenic Hg pollution. In coastal zones, Hg present in runoff from local rivers is added to the water column in addition to the more common dissolved gaseous Hg that was originated in remote regions and was deposited from the atmosphere. Variable mat Hg concentrations, which reflect uptake and bioaccumulation into plant tissues during growth, correspond to known mining and metalworking activities in European history, including Roman mining, metallurgy in the Late Middle Ages, and modern industrial practices. Moreover, Hg concentrations decreased or leveled off after periods when drastic economic changes halted mining activities, such as the fall of the Roman Empire and the spread of the plague across Europe in the 14th century. — NW

Global Biogeochem. Cycles **27**, 10.1029/2012GB004296 (2013).



CREDITS (TOP TO BOTTOM): MIKAEL PITTET; YORUNO/WIKIMEDIA COMMONS

PHYSICS

Following a Single Imperfection

Quantum simulation aims to explain the behavior of a complicated physical system by using a more ordered and controllable equivalent. Over the past decade, such quantum simulators have been realized in quantum gases loaded in optical lattices, which simulate crystal structures in real materials and are formed by counterpropagating laser beams. Quantum magnetism, which is thought to play a major role in high-temperature superconductors and spin liquids, is a prime goal for such efforts. Fukuhara *et al.* observed the dynamics of a single spin impurity in a linear chain of ~10 atoms with magnetic interactions as the regime was varied from deep confinement to a delocalized superfluid state. The impurity was created with exquisite control by flipping the direction of the middle spin in the chain, whereas the other spins remained in the initial uniform state; the propagation of the impurity was tracked by imaging individual sites. The results agreed well with numerics and showed evidence of collective polaronic behavior in the superfluid limit. — JS

Nat. Phys. 10.1038/nphys2561 (2013).