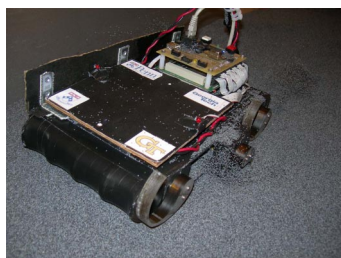


- 3029 Robotic locomotion in complex terrains
 3041 Improving nitrogen management
 3348 Preventing neurotoxicity in Alzheimer's disease
 3496 Astrocytes signal through radiating calcium waves
 3603 Maize meiosis checkpoint

PHYSICS

Robotic locomotion in complex terrains

Legged robots have a long way to go before they can attain the speed and control exhibited by living organisms, especially on granular surfaces. Granular materials exhibit a wide range of material properties and can behave as solids, gases, liquids, or



SandBot running on granular media.

glasses depending on the applied stress. Adapting to such a shape-shifting base exceeds the capability of most robots. Chen Li et al. conducted experiments with SandBot, a bioinspired robot with six C-shaped legs driven by rotating axles, and noted that the machine's performance depends on the frequency of its leg rotation and the packing fraction of the granular material that provides traction. The authors observed that, as the leg frequency increases or the packing fraction decreases, the robot undergoes a transition from walking to less-efficient "swimming." The transition occurs over a remarkably narrow window. A model developed by Li et al. captures most of the behavior and shows that the failure transition is typically due to the increasing penetration of the limbs into the granular stratum and the disturbances in the material from the flailing legs. A better understanding of granular physics could enable higher performance by the robot, according to the authors. — K.M.

"Sensitive dependence of the motion of a legged robot on granular media" by Chen Li, Paul B. Umbanhowar, Haldun Komsuoglu, Daniel E. Koditschek, and Daniel I. Goldman (see pages 3029–3034)

AGRICULTURAL SCIENCES

Improving nitrogen management

In the past 40 years, the nitrogen cycle has changed from a system driven almost entirely by natural forces to one where anthropogenic fertilizers and fossil fuels play a major role. The

use of synthetic fertilizers and a double-cropping system in China have helped the country achieve food sufficiency, although the country's use of fertilizer outstrips its improvements in food production.

Xiao-Tang Ju et al. compared current agricultural practices to optimum nitrogen fertilization methods and found that optimizing fertilizer application could reduce the amount of fertilizer used by 30% to 60% with no decrease in crop yields. The optimal methods resulted from research study-

ing the quantity and timing of nitrogen-based fertilizer application in rice/wheat and wheat/maize crop systems, two of the most intensive and widely practiced agricultural systems throughout Asia. The authors found that rice/wheat systems had higher rates of nitrogen loss and lower nitrogen retention rates compared with wheat/maize systems, resulting in little utilization of residual nitrogen by the succeeding crop. The use of optimum nitrogen fertilization methods could help balance potential environmental damage with crop yields, the authors conclude. — C.A.

"Reducing environmental risk by improving N management in intensive Chinese agricultural systems" by Xiao-Tang Ju, Guang-Xi Xing, Xin-Ping Chen, Shao-Lin Zhang, Li-Juan Zhang, Xue-Jun Liu, Zhen-Ling Cui, Bin Yin, Peter Christie, Zhao-Liang Zhu, and Fu-Suo Zhang (see pages 3041–3046)

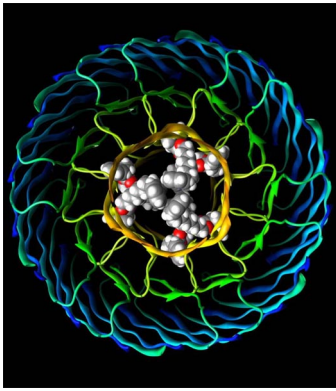


Nitrogen fertilizer application. Image courtesy Xiao-Tang Ju.

MEDICAL SCIENCES

Preventing neurotoxicity in Alzheimer's disease

The accumulation of amyloid beta oligomers in the brain causes neurotoxicity and the memory loss characteristic of Alzheimer's disease. The oligomers may damage neurons by creating calcium conducting channels in the neuronal membrane bilayer, ultimately leading to cell death. Juan Carlos Diaz et al. identified two amphiphilic pyridinium salts that block the calcium



Calcium channels created by amyloid beta oligomers.

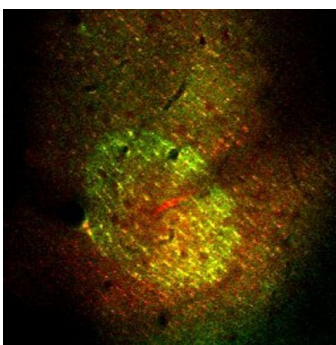
channel and may protect neurons from amyloid beta oligomer toxicity. The authors tested enantiomers MRS2481 and MRS2485 on a neuronal cell culture over 3 days and found both compounds prevented intracellular calcium accumulation with equal efficacy. However, MRS2485 binds irreversibly to the calcium channel, while MRS2481 is easily washed out. Additional experiments showed that the compounds attenuate the subconductance of the calcium channel before blocking the channel entirely. Given the relationship between neurotoxicity and the formation of calcium channels by amyloid beta oligomers, these compounds may provide promising candidates for treating Alzheimer's disease, the authors conclude. — C.A.

“Small molecule blockers of the Alzheimer $A\beta$ calcium channel potently protect neurons from $A\beta$ cytotoxicity” by Juan Carlos Diaz, Olga Simakova, Kenneth A. Jacobson, Nelson Arispe, and Harvey B. Pollard (see pages 3348–3353)

NEUROSCIENCE, PHYSICS

Astrocytes signal through radiating calcium waves

Astrocytic glial cells, a type of nonneuronal cell in the brain, play important roles in brain activities and key functions like energetics. Like many eukaryotic cell types, astrocytes mobilize calcium from internal stores, creating a signal that can spread from cell to cell. Tycho Hoogland et al. found that in the intact cerebellum, this calcium signal



ATP-triggered calcium wave in the cerebellar molecular layer.

passes through many astrocytic processes in an ellipsoid-shaped wave without fully encompassing any one cell. This research demonstrates the ability of nonneuronal cells to generate a regional activation signal. In live, anesthetized rodents, the authors employed 2-photon microscopy in combination with synthetic calcium indicators or viral expression of G-CaMP2, a genetically encoded calcium

sensor protein, targeted to Bergmann glia, which are cerebellar astrocytes that extend radial processes through the molecular layer. The production of ellipsoidal calcium waves required the local release of a small purine, and drugs that blocked P2 purine receptors suppressed calcium mobilization. The authors found that waves recurred in the same location, and waves from different areas could overlap with other signals. Future studies are needed to reveal the role radiating waves play in blood flow regulation, neuroprotection, and the guidance of synaptic plasticity, according to the authors. — F.A.

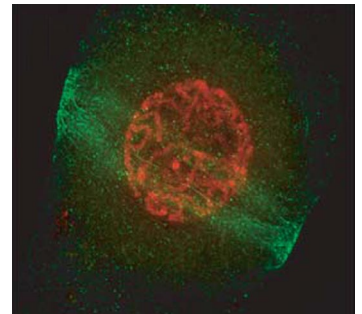
“Radially expanding transglial calcium waves in the intact cerebellum” by Tycho M. Hoogland, Bernd Kuhn, Werner Göbel, Wenying Huang, Junichi Nakai, Fritjof Helmchen, Jane Flint, and Samuel S.-H. Wang (see pages 3496–3501)

PLANT BIOLOGY

Maize meiosis checkpoint

Meiosis, the halving and separation of genetic material into germ line cells, is a process conserved in sexual reproduction. The sequences of molecular events that initiate meiosis vary widely depending on species; observations have been made in yeast and in mice.

Wojciech Pawlowski et al. have now characterized the effects of mutations in *AMEIOTIC1*, an important protein regulator of meiosis in maize. Using fluorescence microscopy, the authors investigated how 5 *AMEIOTIC1* mutations affect the early stages of meiosis. Four of the mutations prevented meiosis and strongly resembled mitosis. The fifth mutation allowed entry into meiosis, but halted progression at the hitherto-unknown leptotene-zygotene transition. *AMEIOTIC1* appears to be exclusive to plants, based on a BLAST search, although it appears to be present in monocots and dicots. One of the 2 homologs in *Arabidopsis* is known to participate in meiosis, but performs a different role to its cousin in maize. The initiation of meiosis, because it is central to development of the organism, may prove diverse even within the plant kingdom, the authors say. — K.M.



Mitotic preprophase band in mutant maize meiocytes.

*“Maize *AMEIOTIC1* is essential for multiple early meiotic processes and likely required for the initiation of meiosis”* by Wojciech P. Pawlowski, Chung-Ju Rachel Wang, Inna N. Golubovskaya, Jessica M. Szymaniak, Liang Shi, Olivier Hamant, Tong Zhu, Lisa Harper, William F. Sheridan, and W. Zacheus Cande (see pages 3603–3608)