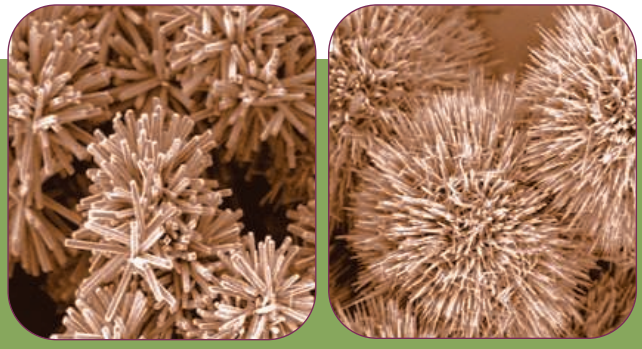
EDITORS' CHOICE

edited by Stella Hurtley



Dendritic structure produced at 120°C (left) and 180°C (right).

CHEMISTRY

Inorganic Dendrites

Manganese oxides are used in batteries, chemical separation, and catalysis because of their porosity, acidity, and ion exchange properties. Organic templates have been used to make complex architectures but require subsequent purification of the end product with the risk of residual organic material remaining as impurities. Manganese oxides have previously been fabricated into octahedral molecular sieves that possess microporous tunnel structures, but the particles have not possessed uniform shapes or any sort of three-dimensional ordering. Yuan *et al.* have now developed a synthesis protocol that mixes potassium dichromate and manganese sulfate monohydrate under mild hydrothermal conditions to generate defined three-dimensional structures. Control of the resulting structures is achieved solely by varying the autoclave temperature from 120° to 180°C. Smaller crystals form at the higher temperature, creating a dendritic structure with finer and denser needlelike branches. The key to the control comes from the fact that the redox potential of $Cr_2O_7^{2-}/Cr^{3+}$ is only slightly larger than that of Mn^{4+}/Mn^{2+}, so that the reaction is slow. This gives precise control over the nucleation and growth processes leading to highly uniform dendritic structures. — MSL

J. Am. Chem. Soc. 10.1021/ja053463j (2005).

BIOCHEMISTRY

Protein Waves

Molecular dynamics are essential to protein stability and function. Nuclear magnetic resonance methods can measure residual internuclear dipolar couplings, which report on the average orientations of internuclear vectors on the slow time scales that are important for many biological processes (up to milliseconds). Bouvignies *et al.* took an in-depth look at the dynamics of an immunoglobulin-binding domain of streptococcal protein G and identified a long-range network of correlated motions. In the β sheet, an alternating pattern of dynamics resembled a standing wave: Nodes were associated with strongly hydrophobic side chains buried in the core of the protein that probably anchor the backbone motions as they propagate across the β sheet. The motion was correlated across hydrogen bonds, suggesting that dynamic information is transmitted across hydrogen bond networks. Independent confirmation of the dynamic network was provided by hydrogen-bond scalar coupling analysis. The amplitude of motion increased across the sheet, so that the greatest flexibility was in the strand that interacts with the antigen-binding domain of immunoglobulin G. Similar processes of information transfer through hydrogen bond networks may be important in processes such as allosteric regulation. — VV

Proc. Natl. Acad. Sci. USA **102**, 13885 (2005).

ECOLOGY/EVOLUTION

Geography of Gene Swapping

Horizontal gene transfer between unrelated species has not been uncommon in the course of biological evolution. Recently discovered examples have included the transfer of mitochondrial genes from parasitic flowering plants to their flowering plant hosts, and vice versa. Davis *et al.* now document horizontal gene transfer between more distantly related plants: Part of the mitochondrial genome of the rattlesnake fern, *Botrychium virginianum*, appears to be derived from sequences characteristic of mitochondria of the parasitic sandalwoods and mistletoes. The angiosperm sequences are present across the entire Northern Hemisphere range of the rattlesnake fern but are absent from any of its close relatives. These and other biogeographic and life-history data suggest that the horizontal gene transfer occurred quite recently in the ancestry of *B. virginianum* and was followed by rapid expansion to its current wide distribution. How this transfer occurred remains speculative—plausible mechanisms include direct transfer from a now-extinct parasite to an ancestor of the fern, or indirect transfer via mycorrhizal fungi. — AMS

The rattlesnake fern, *B. virginianum*.

Proc R. Soc. London Ser. B 10.1098/rspb.2005.3226 (2005).

HUMAN GENETICS

An RNA of Stature

Human growth and stature are regulated in part by the signaling pathways that control cell division and growth. Molecular insights into these pathways have come from the analysis of human mutations that confer clinical abnormalities in stature. One interesting example is cartilage-hair hypoplasia (CHH), a mild form of dwarfism that has been traced to mutations in the RNA subunit of a ribonucleoprotein enzyme (MRP) that cleaves RNA but whose mechanistic role in pathogenesis has been unclear.

Thiel *et al.* now show that different mutations in MRP RNA cause anauxetic dysplasia, a rare genetic disorder characterized by extreme short stature (adult height <85 cm). After comparing the various mutant RNAs in functional assays, the authors suggest that the clinical differences may arise from differential effects of the mutations on two distinct cellular pathways. Whereas the anauxetic dysplasia mutations appear to severely disrupt processing of ribosomal RNA (presumably leading to inhibition of protein synthesis), the CHH mutations have a modest effect on this pathway but simultaneously disrupt the

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CREDITS: (TOP) YUAN *ET AL.*, *J. AM. CHEM. SOC.* 10.1021/JA053463J (2005); (BOTTOM) ROBBIN MORAN

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processing of an mRNA encoding a key cell-cycle regulator. — PAK

Am. J. Hum. Genet., in press.

ENGINEERING

Integrated Microfluidics

Microfluidics involves the handling and manipulation of very small fluid volumes, and there is much hope that small, portable, and low-cost devices can be designed for tackling global health problems. Pal *et al.* have been able to fabricate a complex device that integrates heaters, temperature sensors, and valves that can control nanoliter-volume reactors in series followed by an electrophoretic separation. Because the key components are electronically addressable, it should be possible to make the device operate autonomously. The device was used for a number of analyses, including the subtyping of two strains of influenza and the amplification of human DNA, mouse plasmid DNA, and plasmid DNA of one of the flu strains. Currently, the device costs about $7 per unit to make, but this can be reduced to below $1 by scaling down the features by an order of magnitude while retaining functionality. It remains to be determined whether sample preparation will be integrated into the device or remain offline and how portable the device will become. — MSL

Lab on a Chip **5**, 1024 (2005).

CHEMISTRY

Looking at SO_2

Optical sensors for SO_2, a colorless pollutant, have relied on secondary indicators, such as those that detect pH changes or detect byproducts of SO_2 reactions. Leontiev and Rudkevich have focused on a long-known but apparently little-used aspect of SO_2 chemistry: its ability to form adducts with amines by accepting their lone-pair electrons. Binding of amines such as piperidine or diethylamine to Zn-tetraphenylporphyrin in chloroform solution shifts its color from red to dark green. Addition of SO_2 displaces the amine and turns the solution back to red. Because of the specificity of adduct formation, molecules such as CO, CO_2, H_2O, or N_2O had no effect on the indicator, which is sensitive down to the low millimolar range. — PDS

Color change from red to green and back to red

J. Am. Chem. Soc. 10.1021/ja053260v (2005).

CREDITS: LEONTIEV *ET AL.*, *J. AM. CHEM. SOC.* 10.1021/JA053260V (2005)

HIGHLIGHTED IN *SCIENCE*'S SIGNAL TRANSDUCTION KNOWLEDGE ENVIRONMENT

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Converting Repulsion to Attraction

Growth cones guide neurons to their targets by monitoring chemoattractive and chemorepellant cues. Many cues elicit localized increases in cytosolic free calcium concentration ($[Ca^{2+}]_c$) but, curiously, both attractive and repulsive diffusible cues can increase local $[Ca^{2+}]$ so that the growth cone turns toward (attraction) or away from (repulsion) the side with greater $[Ca^{2+}]_c$. Ooashi *et al.* used focal laser-induced photolysis of caged Ca^{2+} to transiently increase local $[Ca^{2+}]_c$ in the growth cones of dorsal root ganglion neurons grown on different substrates. Neurons grown on L1 or N-cadherin substrates turned toward, whereas neurons grown on laminin turned away from, the side on which $[Ca^{2+}]_c$ was greater. Neurons grown on L1 and N-cadherin substrates showed increased cyclic AMP (cAMP) binding to the regulatory subunits of cAMP-dependent protein kinase. Inhibition of cAMP signaling converted Ca^{2+}-mediated attraction to repulsion, whereas pharmacological activation of protein kinase A converted Ca^{2+}-mediated repulsion to attraction. Analysis of calcium signals and of the turning behavior of neurons from mice lacking the type 3 ryanodine receptor isoform (RyR3) implicated RyR3 in protein kinase A–dependent calcium-induced calcium release and attractive turning. The source of the cytosolic Ca^{2+} signal—rather than its amplitude—determined turning behavior. Thus, a Ca^{2+} signal that triggers calcium-induced calcium release from intracellular stores stimulates attractive turning, whereas a Ca^{2+} signal without calcium-induced calcium release elicits repulsion. — EMA

J. Cell Biol. **170**, 1159 (2005).

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