

CHEMISTRY

Getting Metathesis Started

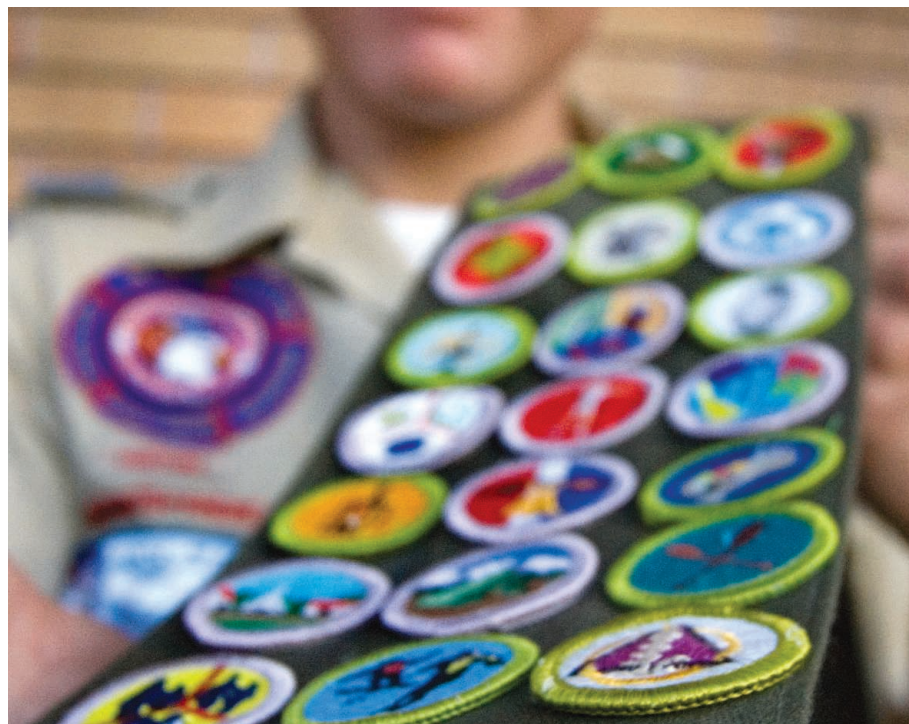
When olefin metathesis garnered the Nobel several years ago, the process was frequently analogized to a dance in which the participants switched partners. In this context, one question that continues to occupy researchers is how best to start the music, or activate the catalyst that steers olefinic carbons to and fro. A key step in activation of the widely used class of ruthenium-based catalysts is dissociation of a phosphine ligand, which creates a vacancy where the olefin can bind. Coordination of a strong donor ligand opposite the phosphine ought to accelerate this initial step, but in practice the observed acceleration is lower than expected. Yang *et al.* have now explored this puzzle using density functional theory calculations, and they find that the trouble arises because the phosphine dissociation is not an isolated process. Instead, it is coupled to rotation of the carbene ligand bound in the orthogonal plane (which will eventually couple to one of the olefin's carbons and get the dance started). This rotational motion upends the expected trends in expelling phosphine, but also facilitates subsequent olefin binding in a reactive orientation—the ultimately redeeming feature of using the stronger donor ligand. Such insights may facilitate design of more efficient next-generation catalysts. — JSY

Organometallics 30, 10.1021/om200529m (2011).

MICROBIOLOGY

Easy Escape

Antibiotic resistance is escalating, driven mostly by human activities, but whether low amounts of antibiotic pollution also contribute to antibiotic resistance is unclear. For several well-defined mutants of *Escherichia coli* and *Salmonella enterica*, Gullberg *et al.* tested how little antibiotic is needed to enrich for resistant bacteria. Using tetracycline, fluoroquinolone, and aminoglycoside antibiotics in competition experiments between susceptible and resistant bacteria, they found selection for resistance occurring at picogram to nanogram concentrations. They specify this threshold as the minimal selective concentration, which is the concentration at which the fitness cost of resistance is balanced by the selective advantage of the mutation. Twenty susceptible lineages of *S. typhimurium* grown in the presence of low concentrations of streptomycin contained subpopulations tolerating eightfold greater concentrations of streptomycin by 400 generations. Thus, the surprisingly high frequencies of antibiotic-resistant bacteria found



EDUCATION

Gauging Merit in the Badge

The Boy Scout merit badge program is an informal educational experience allowing Scouts to explore a variety of subjects, including science. Scouts can earn up to 23 science merit badges. General requirements for science merit badges use verbs such as show, demonstrate, make, list, discuss, collect, identify, and label. Vick and Garvey use the revised Bloom's taxonomy, a method for evaluating educational goals on the basis of six levels of cognitive processes (remembering, understanding, applying, analyzing, evaluating, and creating) to assess these requirements. Frequency counts of verbs; the actions Scouts had to take; and elements, the number of times that a Scout performed a certain skill, were used to evaluate the level of cognitive processes required to earn a science merit badge. Results showed that although these requirements involved factual recall, personal understanding, and application of the material, evaluation and creativity, considered to be higher-level thinking skills, did not receive much emphasis. Although familiarity with scientific terms is not an unacceptable goal, providing only this in informal science experiences is a missed opportunity, and Scouting and other informal education programs will benefit from the addition of more requirements that use evaluation and creation. — MM

Int. J. Environ. Sci. Edu. 6, 173 (2011).

in animals from relatively pristine environments may be explained by this low-concentration enrichment effect. — CA

PLoS Pathol. 7, e1002158 (2011).

NEUROBIOLOGY

A Lysosomal Culprit

Parkinson's disease (PD) has been clinically linked to a rare lysosomal storage disease known as Gaucher disease (GD). Patients with GD lack the enzyme glucocerebrosidase (GCase), which

leads to the accumulation of the glycolipid glucosylceramide. In PD, intracellular accumulation and aggregation of the α -synuclein protein in neurons is a key event in disease pathogenesis. Mazzulli *et al.* wanted to elucidate the mechanistic link between these two disorders. In neuronal tissue culture systems and in mouse disease models, intracellular accumulation of glucosylceramide compromised lysosomal proteolysis and led to the accumulation of cytotoxic α -synuclein and neurodegeneration. Furthermore, glucosylceramide directly promoted the aggregation of

purified α -synuclein in vitro. The accumulation of the α -synuclein itself in neurons also compromised the production of mature, active lysosomal GCase, generating a pathogenic cycle. Analysis of postmortem brain samples from human patients also suggested that GCase deficiencies were often linked to pathological α -synuclein accumulation. Intervention in this pathogenic cycle by increasing the efficiency of GCase targeting to lysosomes may thus represent a future approach toward ameliorating PD and other related diseases. — SMH

Cell **146**, 37 (2011).

DEMOGRAPHY

You Are What You Eat

Potatoes were brought to the Old World from South America at the end of the 16th century. The total population of the Old World and the movement of people from farms to cities increased severalfold between 1700 and 1900. In order to assess the extent to which the former contributed to the latter, Nunn and Qian have analyzed Old World historical data and focused on two kinds of variation: the times at which potatoes were introduced and the places at which geophysical conditions were well suited for potato cultivation. The balanced nutrients and calories supplied by the potato explained its value as a subsistence crop, especially in comparison to other staples such as wheat, oats, and barley (the recent deciphering of its genome by the Potato Genome Sequencing Consortium may lead to the development of disease-resistant varieties). Equally important, much of Europe was well placed to offer a favorable growing environment, and the authors attribute 20 to 30% of the increase in population and urbanization to the introduction of the potato. Urbanization reflected the improved productivity of agriculture and the subsequent transfer of labor from farms to cities, which in turn promoted economic growth. — GJC

Q. J. Econ. **126**, 10.1093/qje/qjr009 (2011);

Nature **475**, 189 (2011).



PLANT SCIENCE

Symbiont Sensing

When symbiotic bacteria infect the roots of legumes, complex mutual signaling pathways regulate the interaction and developmental

responses that lead to a nitrogen-fixing nodule on the plant root. Nitrogen fixation by the bacteria provides a usable nitrogen source to the plants, whereas the plant provides a carbon source for the bacteria. The plant receptor LYK3 is critical for the infection process. Haney *et al.*, observing LYK3 labeled with a fluorescent tag, showed that LYK3 is associated with the plasma membrane, where it has some mobility in uninfected root hairs. Inoculation with symbiotic bacteria altered the mobility of LYK3 within the plant root hairs so that in many cells, LYK3 became localized into puncta and colocalized with another protein, FLOT4, which is required for infection. These changes in the cellular location of receptors probably regulate the infection process. — PJH

Plant Cell **23**, 10.1105/tpc.111.086389 (2011).

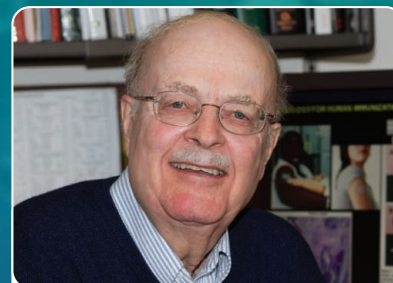
PHYSICS

Enhancing Quantum Coupling

It's almost hard to believe, now that computers and their associated electronics have so thoroughly permeated modern life, that their components were once the stuff of fundamental physics research, the future applications barely envisioned. Such is the current state of quantum computing. An efficient quantum information architecture will be expected to allow the storage, retrieval, manipulation, and transfer of single bits of information around a network of qubits and quantum memories—ideally in a controllable and deterministic way. Proof-of-principle experiments have shown that such information encoded in a single photon, for example, can be stored on a single trapped atom or ion. However, the coupling between the ion or atom and the photon is rather weak, so the process occurs with rather low probability. Lamata *et al.* provide a possible solution that should enhance the coupling between the single ion and the single photon. They suggest that a linear chain of ions trapped in a cavity would act as an effective antenna for an incoming photon and that the state of the photon would be mapped across the entire chain. They include another step in the process that involves the optical manipulation of the linear chain of ions so that the collective excitation is then focused onto a single ion. The process is reversible, so that the information encoded in the internal state of the ion can be mapped onto the linear chain and then encoded onto a photon exiting the cavity. — ISO

Phys. Rev. Lett. **107**, 030501 (2011).

“A dream told me to do it.”



Carl R. Alving, M.D.
Chief of the Department of Adjuvant & Antigen Research, Division of Retrovirology at the Walter Reed Army Institute of Research
AAAS member

*Dr. Carl Alving
on his inspiration
for inventing
the vaccine patch.*

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