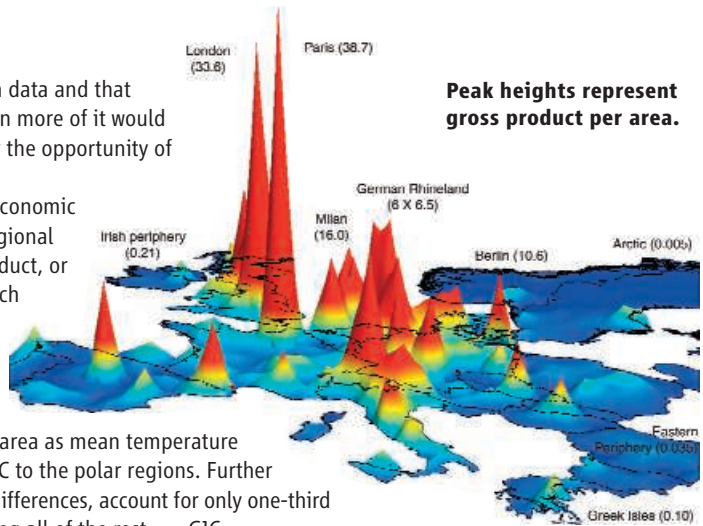
HIGHLIGHTS OF THE RECENT LITERATURE

ECONOMICS

Highlands and Lowlands

It might seem that nowadays we're already drowning in too much data and that devoting more energy to interpreting it and less to collecting even more of it would be advisable. On the other hand, large amounts of data can offer the opportunity of looking at old questions in new ways.

Nordhaus describes the construction of a geographically scaled economic data set (G-Econ) that transforms the economic quantity gross regional product (where a region can be a nation, as in gross national product, or a smaller political subdivision) along geophysical dimensions, such as temperature or coastal proximity. Aggregating economic data across multiple sources and scaling output to a cell size of 1° longitude by 1° latitude yields the gross cell product or GCP.



Peak heights represent gross product per area.

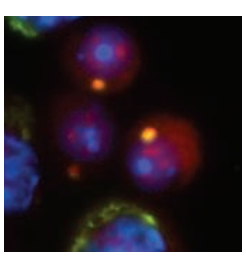
The established finding that output per person increases with distance from the equator converts into a decrease in output per area as mean temperature decreases, with a decline of 10^5 from the maximum at about 10°C to the polar regions. Further analysis reveals that country-specific effects, such as institutional differences, account for only one-third of this variation, with geography contributing to but not explaining all of the rest. — GJC

Proc. Natl. Acad. Sci. U.S.A. **103**, 10.1073/pnas.0509842103 (2006).

MOLECULAR BIOLOGY

Gathering in the Clouds

The chromatoid body, an electron-dense structure in the cytoplasm of mammalian male germ cells, was first described more than a century ago (see review by Parvinen); it may correspond to *Drosophila* nuage, which is a cloud-like fibrous material seen in germ cells. During spermatogenesis, the chromatoid body moves around, associating with the Golgi complex, mitochondria, and nuclear pores. The absence of DNA and the presence of RNA and the RNA helicase MVH (the mouse VASA homolog) have contributed to the belief that this structure is involved in the handling and storage of messenger RNAs (mRNAs).



MVH (green) and mRNA (red) in chromatoid bodies.

Kotaja *et al.* demonstrate that the chromatoid body contains the same kinds of molecules that are found in the processing bodies of mammalian somatic cells and yeast. The endonuclease Dicer generates small RNAs that are then assembled with Argonaute into an RNA-induced silencing complex (RISC), which mediates the degradation and translational arrest of mRNAs. The authors show that Dicer interacts with MVH and that Dicer, Argonaute, and mRNA all localize to the chromatoid body. They suggest that, as an early step in posttranscriptional regulation of gene expression, both mRNAs and small RNAs may be captured by the chromatoid body as they transit the nuclear pores. — GJC

Int. J. Androl. **28**, 189 (2005); *Proc. Natl. Acad. Sci. U.S.A.* **103**, 2647 (2006).

CHEMISTRY

Enantioselective Emulsions

Although enzymes achieve extraordinary selectivity in catalyzing biochemical reactions, they operate in relatively dilute environments. To adapt enzymatic catalysis for cost-effective industrial-scale synthesis, it would be desirable to increase the reagent concentrations substantially. One approach has been to solubilize reagents by adding an organic co-solvent to aqueous solutions of the enzyme; however, the reaction rates in such biphasic systems are hindered by slow mixing kinetics.

Gröger *et al.* have used mini-emulsions to improve mixing efficiency by increasing the interface area between dissolved enzymes and substrates. They focused specifically on lipase-catalyzed kinetic resolutions of racemic α– and β– amino acid esters to the respective homochiral free acids. Through ultrasound sonication of aqueous solutions containing 1% surfactant and 1% hydrophobic hexadecane, the authors generated stable emulsions of 100-nm-diameter droplets containing the ester. The exceptionally high ester concentration under these conditions cut the reaction time to less than half that for a traditional biphasic system, while maintaining >99% enantioselectivity. — MSL

Angew. Chem. Int. Ed. **45**, 1645 (2006).

CELL BIOLOGY

Reinforcing the Scaffold

During cell division, chromosomes condense into their stereotypical compact rod-like shapes, and this allows them to be manipulated efficiently by the mitotic spindle for partitioning into the daughter cells. Using fluorescence microscopy on live cells, Gerlich *et al.* examined the roles of the condensin proteins I and II in chromosome restructuring during mitosis. Condensin II remained associated with chromosomes throughout mitosis, whereas condensin I began to associate with chromosomes in prometaphase, after compaction had been completed in prophase. As mitosis progressed, the levels of chromosome-associated condensin I increased, until chromosomes had lined up on the mitotic spindle, for partitioning during anaphase. When levels of condensin I were reduced experimentally, chromosomes condensed normally, but during alignment and separation, the compacted chromosomes were mechanically unstable and more readily disrupted. In contrast, when levels of condensin II were reduced, condensed chromosomes remained robust enough to withstand partitioning. Thus, it

Continued on page 1349

CREDITS (TOP TO BOTTOM): NORDHAUS *ET AL.*, *PROC. NATL. ACAD. SCI. U.S.A.* **103**, 10.1073/PNAS.0509842103 (2006); KOTAJA *ET AL.*, *PROC. NATL. ACAD. SCI. U.S.A.* **103**, 2647 (2006)

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Continued from page 1347

seems that condensin I reinforces the scaffold of condensed chromosomes and helps them to withstand the forces applied as they interact with the mitotic spindle. — SMH

Curr. Biol. **16**, 333 (2006).

APPLIED PHYSICS

Scanning Nanobarcodes

Screening technologies for biological and chemical monitoring often depend on the ability to identify and track labeled substrates. Although carrier beads can be encoded optically with fluorescence, infrared, or Raman spectroscopic signatures, the number of discriminable markers or tags available via these techniques is limited.

To expand the pool of markers, Galitonov *et al.* introduce an alternative method, based on the characteristic diffraction patterns produced by nanostructured barcodes. The operating principle relies on the distinctive image that results when laser light is scattered from a periodic grating, with the diffraction angles of the first and higher-order lines determined by the grating's periodicity. Each grating thus encodes a unique signature; moreover, superposition of two or more gratings creates a complex pattern, distinct from the image produced by either grating alone. By fabricating 100-μm-long barcodes from just three superposed gratings, the authors demonstrate the capacity to create a library of 68,000 distinctive tags, each readily readable by a helium-neon laser. With library sizes expected to increase as more gratings are superposed and fabrication resolution is improved, the method should find use in a variety of high-throughput screening applications. — ISO

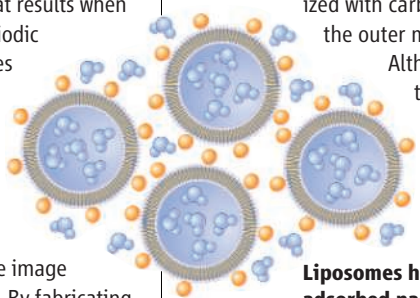
Opt. Express **14**, 1382 (2006).

MATERIALS SCIENCE

Like Repels Like

Liposomes—microscopic compartments surrounded by a phospholipid bilayer shell—are of interest for targeted drug delivery. However, their high surface curvature renders them vulnerable to fusing when they collide, which can result in the premature release of their contents; many efforts to address this deficiency have relied on significant modifications of the liposome surface structure.

Zhang and Granick have stabilized 200-nm-diameter liposomes against fusion through a minor modification: the adhesion of negatively charged nanoparticles (polystyrene functionalized with carboxylate groups) to the outer membrane surface. Although only one-quarter of the surface was occluded by the nanoparticles, charge repulsion was sufficient to prevent fusion, stabilizing a 16% by volume liposome suspension for 50 days. The authors further demonstrated the robustness of the structures by filling them with a fluorescent dye and observing no leakage over 4 days. — PDS



Liposomes held apart by adsorbed nanoparticles (orange).

Nano Lett. **6**, 10.1021/nl052455y (2006).

CREDIT: ILLUSTRATION: CHRIS BICKEL/*SCIENCE*, ADOPTED FROM ZHANG AND GRANICK, *NANO LETT.* 6, 10.1021/NL052455Y (2006)

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<< The Ups and Downs of Kinases

Jeffrey *et al.* explored the role of the nuclear-localized dual specificity phosphatase (DUSP) isoform known as phosphatase of activated cells 1 (PAC-1, which is encoded by the DUSP2 gene) in the regulation of leukocyte activity and in a mouse model of autoimmune arthritis. Surprisingly, cells from Dusp2$^{-/-}$ mice showed decreased induction of inflammatory arthritis (delayed onset of symptoms and diminished histological and clinical features). Stimulated macrophages and bone marrow–derived mast cells from these mice exhibited reduced gene expression and secretion of inflammatory mediators; in addition, cultured mast cells exhibited greater apoptosis and decreased cell survival. Despite in vitro evidence that the mitogen-activated protein kinases (MAPKs) p38 and ERK are substrates of PAC-1, their activities decreased in the Dusp2$^{-/-}$ mast cells and macrophages. In contrast, phosphorylation of the MAPK c-Jun N-terminal kinase (JNK) increased. PAC-1 deficiency reduced gene expression by the transcriptional regulator Elk1, and inhibition of JNK in PAC-1 deficient cells rescued ERK phosphorylation and Elk1-mediated transcription, suggesting that the JNK pathway regulates the ERK pathway so that when JNK activity goes up, ERK activity goes down. These results point to therapeutic targeting of PAC-1 as a modulator of MAPK signaling in immune cells, especially for treatment of autoimmune disease. — NRG

Nat. Immunol. **7**, 274 (2006).

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