EDITORS' CHOICE

edited by Gilbert Chin

ASTROPHYSICS

Planet Probabilities

Models of planet formation favor accretion into spheres in protoplanetary disks around young stars. The smaller, rocky planets (Earth-like) would form closer to their central star where the more refractory metals (elements heavier than helium) can accrete, and the larger, icy planets (Jupiter-like) would form farther from their central star where volatile-rich ices can accumulate. The Jupiter-like planets could then migrate inward, causing any Earth-like planets to be pushed into the star, increasing the star's concentration of metals (metallicity). About 40 "hot Jupiters" (Jupiter-like planets that have migrated to smaller orbits) have been detected, and at least 32 of these planets orbit stars that are richer in metals than typical solar-mass stars.

Lineweaver analyzes the correlation between stellar metallicity and hot Jupiters in order to estimate the distribution of Earth-like planets in the universe. High metallicity translates into a high probability of the presence of a hot Jupiter, whereas low metallicity would yield a low probability of finding any kind of planet. A moderate metallicity would result in the highest probability of an Earth-like planet, and Lineweaver estimates that 74% of the possible Earth-like planets in the universe are older than Earth by at least 2 billion years. Thus, in addition to the challenge of locating these Earth-like planets, we will need to consider how other life may have evolved, given a head start. — LR

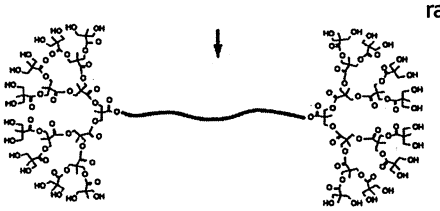
Icarus **151**, 307 (2001).

POLYMER SCIENCE

Growing Large Molecules

Dendrimers, also known as cascade molecules, are polymers in which several layers of highly branched repeating units emanate from a central core. Two synthetic approaches are common: Convergent growth starts from the outside layer inward, whereas divergent growth begins at the central core. The former method allows for greater purity and branch control, whereas the latter method is favored for larger structures. The selection of a synthesis technique is governed by the required properties of the final product and the available reagents.

Inspired by the need for a less toxic, biocompatible aliphatic dendrimer for drug delivery, Ihre *et al.* have developed a divergent anhydride-coupling technique that requires no additional purification techniques beyond solvent extraction and precipitation. They prepared a monodisperse sixth-generation dendrimer in high yield. They also synthesized linear-dendritic hybrid polymers, in the shapes of fans, dumbbells, or crossed dumbbells starting from linear or cross-shaped poly(ethylene glycol)–based cores. Molecules produced by these techniques are currently being evaluated as potential catalysts and polymer therapeutics. — MSL



J. Am. Chem. Soc., in press.

ECOLOGY

Reaching for the Sky

Surprisingly few quantitative data have been garnered on the rate at which tropical forest trees reach the upper canopy of the forest. Such information is critical for understanding forest dynamics and for describing the patterns of regeneration of different tree species. Clark and Clark measured height increments over a 16-year period in nine tree species in lowland rain forest at La Selva, Costa Rica. Among shade-tolerant species growing under the forest canopy, they find that the path to the canopy is by no means straightforward. Height growth potential increases with increasing sapling size. Average height increments are typically much less than the maxima, and individuals frequently encounter setbacks en route to the canopy, often decreasing in height as a result of damage or dieback. Their data suggest that, to reach even halfway to the canopy, a tree might need as long as 35 to 85 years. — AMS

Ecology **82**, 1460 (2001).

GEOCHEMISTRY

A Scarcity of Gas

Temperatures within Earth increase with depth. Much of Earth's heat is generated internally by radioactive decay of U and Th; this decay also produces ^{4}He (alpha particles). A measurement of the flux of ^{4}He at Earth's surface should agree with estimates based on Earth's content of U and Th and the observed heat flow, but the

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Applying tension recruits adhesion molecules (red) as focal contacts develop.

CELL BIOLOGY

Pulling Harder, Standing Firm

Cells grab onto the extracellular matrix (ECM) via the transmembrane protein integrin; inside the cell, integrin is linked to cytoskeletal components, such as vinculin and paxillin, and thus indirectly to actin filaments, whereas the external part of integrin binds to the ECM. Initial dot-like adhesions, known as focal complexes (1 micrometer in size), can convert into the stronger, streak-like focal contacts (3 to 10 μm).

By following fluorescently tagged vinculin or paxillin in living cells and by interference reflection microscopy, Riveline *et al.* were able to monitor the development of focal contacts. This process was dependent on the GTPase Rho, which was known from previous work to activate two downstream targets: the Rho-associated kinase (ROCK) and a profilin ligand called formin or mDia1. Although the direct application of force with a micropipette obviated the need to activate ROCK (and its downstream myosin II target), formin still was required for focal contact formation. Balaban *et al.* have examined the adhesion of cells to micropatterned grids and find a relation between applied force and the size of the contacts. It appears that the dot-like complexes may serve as micromechanosensors that initiate directional assembly of focal contact components in response to locally applied force. — SMH

J. Cell Biol. **153**, 1175 (2001); *Nature Cell Biol.* **3**, 466 (2001).

SOURCE: (LEFT) RIVELINE *ET AL.*, *J. CELL BIOL.* **153**, 1175 (2001); (RIGHT) IHRE *ET AL.*, *J. AM. CHEM. SOC.*, IN PRESS.

measured flux of ^{4}He is much less than what is predicted.

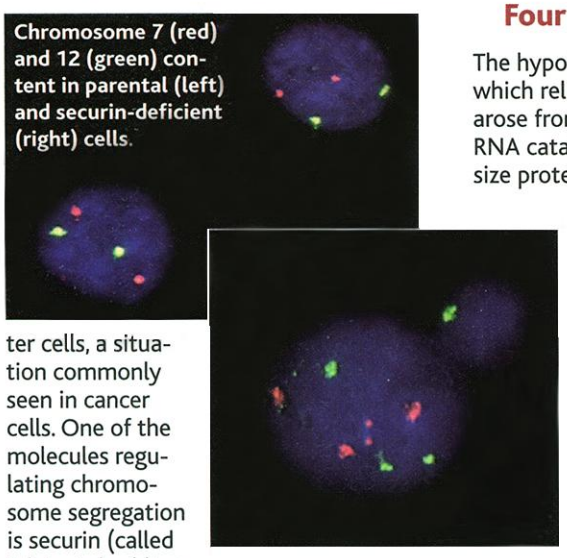
Helium isotopes are used as an important tracer of mantle processes, and, as a gas, it might be thought that helium should simply escape upward. Using a series of models, van Keken *et al.* examine the history of work on this fundamental problem and pose possible solutions. One possibility is that there were massive short-lived releases of helium or heat from Earth's mantle in the geologic past, although this seems unlikely. Alternatively, helium may be efficiently trapped or stored in some part of Earth's mantle, whereas the heat escapes more quickly. — BH

Earth Planet. Sci. Lett. **188**, 421 (2001).

CELL BIOLOGY

Separation Anxiety

In a dividing cell, sister chromatids containing the newly replicated DNA remain tightly associated until the onset of anaphase, at which point they begin to move to opposite poles of the cell. Disruptions in chromatid segregation result in loss or gain of chromosomes in the daughter cells, a situation commonly seen in cancer cells. One of the molecules regulating chromosome segregation is securin (called Pds1p in budding yeast), a protein that paradoxically appears to both inhibit and promote chromatid segregation by altering the functional state of separin, a protease. Separin is required for chromatid separation because it cleaves cohesin, the protein that holds the sister chromatids together.



Chromosome 7 (red) and 12 (green) content in parental (left) and securin-deficient (right) cells.

CREDITS: JALLEPALLI *ET AL.*, *CELL* **105**, 445 (2001).

In work that illustrates how easily cancer cells can acquire a chromosomal instability phenotype, Jallepalli *et al.* show that deletion of the securin gene is in itself sufficient to convert a chromosomally stable human cancer cell into an unstable one that suffers frequent chromosome loss during division. The chromosome loss in the securin-deficient cells is due to impaired chromatid segregation and is associated with defective activation of separin. The viability and continued proliferation of these cells is somewhat surprising, but might be explained by the results of Alexandru *et al.*, who document the existence of a second surveillance system for chromatid segregation that is operative in the absence of securin. In a study of budding yeast, they find that sister chromatid separation is regulated by phosphorylation of serine residues in cohesin near the site cleaved by separin. These phosphorylation events enhance cohesin cleavage and are mediated by Polo/Cdc5 kinase, which has been implicated previously in many aspects of cell cycle control. Finally, in a study of yeast, Clarke *et al.* link Pds1/securin to two distinct cell cycle checkpoints: the G_2 DNA-damage checkpoint and a late S-phase checkpoint. The latter likely ensures that chromatids do not separate until DNA replication is complete. — PAK

Cell **105**, 445; 459 (2001); *Nature Cell Biol.* **3**, 619 (2001).

BIOCHEMISTRY

Four of a Kind

The hypothesis that extant biological life, which relies largely on protein catalysts, arose from an RNA world requires that RNA catalysts existed that could synthesize proteins. This would require four reactions: (i) encoding of protein sequence, (ii) activation of amino acids, (iii) synthesis of aminoacyl-RNA, and (iv) formation of peptide bonds. It previously has been shown that RNA can mediate three of these reactions. The transfer of activated amino acids to an acceptor RNA can be catalyzed by small RNA molecules, and structural studies of the ribosome have revealed that peptide bond formation remains an RNA-catalyzed reaction. Also, there is evidence that some triplet codons are derived from ancient RNA binding sites for the cognate amino acids.

Kumar and Yarus have selected and characterized RNAs capable of activating amino acids. The triphosphate at the 5′ end of the RNA reacts with amino acids, yielding pyrophosphate and the amino acid linked as a mixed anhydride to the RNA. This parallels the synthesis of aminoacyl adenylates catalyzed by modern-day aminoacyl-tRNA synthetases. — VV

Biochemistry **40**, 6998 (2001).