mechanism seems robust; this can facilitate comparative genomic and proteomic studies among species.

Finding the gene(s) responsible for reprogramming will mark a crucial turning point for this technique in the next decade of animal-cloning research. We need to devise more rational experiments that can move the efficiency of somatic cell nuclear transfer closer to that obtained by in vitro fertilization, a welcome improvement for those interested in agricultural and pharmaceutical applications. Unveiling the genes and pathways involved in the cloning procedure is the first step to creating reasonable approaches for generating human cells that can later be used in therapy. Only then will so-called (and still hypothetical) therapeutic cloning become obsolete.

References and Notes

The observation that biological activity in eddies can be very high may help explain why measurements of ocean productivity have varied widely.

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Highly Active Eddies

The oceans, long a source of mystery in science, literature, and exploration, still hold many secrets. How we understand the ocean often depends on the tools used, the time scales of observation, and the internal traditions in subsets of this interdisciplinary field. One long-standing conundrum in ocean biogeochemistry has been the contrast between estimates of basic ocean properties when made at local scales versus estimates that average over whole ocean basins. Two papers in this issue report important advances toward resolving these differences (1, 2).

For many important and interconnected biogeochemical rates—such as the rates of biological productivity at the surface, the rate at which organic matter sinks out of the surface layer, respiration and remineralization in the deep sea, and the mixing of nutrients back to the surfacestimates that should, in theory, all agree have differed by as much as an order of magnitude (1–3). Generally, local measurements give rates that are much lower than estimates that average over very large time and space scales. Mesoscale eddies—swirls in the ocean on scales of 50 to 200 km—are often invoked to explain the discrepancies. The direct measurements of ocean eddies reported in this issue (1, 2) provide crucial support for this idea.

Ocean science has an unintended tradition of undersampling. At each local site, the phytoplankton productivity or amount of sinking organic matter can be directly measured for that location on that day. The oceans are enormous. Ships venture slowly across the sea, stopping occasionally to lower instruments on wires or to collect liters of water for analysis. Over time, the number of discrete measurements has increased slowly, yet the amounts of water that are actually sampled are even less than the proverbial drop in the bucket. Some scientists have therefore searched for ways to measure ocean properties that are inherently averaged over large areas and long time scales. By measuring properties like the concentration of oxygen in the deep sea, coupled to sophisticated estimates of the time since that water last equilibrated with the atmosphere, researchers can create an integrated estimate of the overall level of biogeochemical activity in the basin. These integrated approaches usually yield much higher rates of biological activity than those seen by biologists making direct measurements in the surface ocean. The conundrum could stem from two sources: The measurements themselves could be inaccurate, or the local approaches may not resolve all of the natural variability, missing some very active periods or places. Initially, scientists focused mostly on the measurement techniques for primary production and sinking particles. Trace-metal contamination seems to have resulted in artificially lower estimates of primary production. Sediment traps seem to be sensitive to hydrodynamics, the capture of swimming animals, and dissolution of the particles. Improved methods have helped to close part of the gap (4, 5).

Tracking the eddies. In this series of images of sea surface height in the North Pacific Ocean (to the southeast of the Hawaiian Islands), mesoscale eddies move from east to west and are larger to the south. Two reports in this issue show that such eddies have very high biological activity. [Images from (10)]
At the same time, some previously ignored modes of metabolism, such as nitrogen fixation, were found to be more common than expected, and several groups made tantalizing observations of rare bursts of biogeochemical activity associated with eddies (6–9).

The introduction of new satellite sensors in the 1980s and 1990s exposed oceanography to synoptic views of the sea. It became clear that oceanographers were sampling a highly heterogeneous system, full of important structure that had previously been dismissed as random variability. Measurements of sea surface height (see the figure) clearly showed eddies. Model results suggested that these structures create local areas with increased nutrient supply into the lighted surface waters and patches of enhanced biologic activity.

Could the biological activity in eddies be great enough to make up the rest of the difference between bottles and basins? The results reported by McGillicuddy et al. (10) suggest that they may. The authors show that eddies in the Atlantic can have enough biological activity in a few months to account for the productivity seen in the average patch of water of the same size over the course of a year or more.

However, not all eddies lead to the same biogeochemical outcomes. On page 1017, Benitez-Nelson et al. (2) study a persistent cold-core eddy off Hawaii. It has a plankton bloom with high productivity. In both the Atlantic and Pacific Oceans, diatoms—unicellular plants with a silicious skeleton that are important in creating large sinking fluxes of organic matter—are key organisms. Yet, in the Hawaii eddy, most of the organic matter created by the bloom was still in the surface waters at the end of their period of observation rather than being transported into the deep sea.

The two reports demonstrate that ocean scientists can finally—with intensive observations, tracers, satellites, and models—find, track, and comprehensively sample mesoscale eddies. They also show that these important features of the ocean system are hotspots of rapid biological rates and geochemical transformations that begin to close the historical gap between measurements on local and basin scales.

References and Notes
10. Images were obtained from the Colorado Center for Astrodynamics Research at the University of Colorado, Boulder, via the Global Near-Real-Time Data Viewer (11).

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The Shifting Sands of Asteroids

Erik Asphaug

Although we are growing accustomed to asteroids defying our intuition, the report by Miyamoto et al. on page 1011 of this issue (1), that some small asteroids appear to be clumps of gravel, should come as no small surprise. 433 Eros, the ~33-km-long potato-shaped asteroid visited by NASA's Near Earth Asteroid Rendezvous (NEAR) mission 7 years ago (see the first figure), was originally thought to be a monolithic rock (2), but it turned out to be a shattered mass (3) with seas of mobile regolith (that is, surface dust, gravel, and blocks) (4). As the Japan Aerospace Exploration Agency’s Hayabusa spacecraft approached the much smaller asteroid 25143 Itokawa (5) in 2005, the expectation was more guarded, but one could hardly help but think that with gravity only a few millionths that of Earth—1/100th that of Eros—we would discover an intact nugget. Au contraire. The Hayabusa mission has provided greater evidence than ever for pervasive, global-scale gravity control, leading us to wonder: Are any asteroids monolithic? And if not, what happens when we try to push on one in earnest, as may be required to divert a hazardous asteroid or to corral a resource-rich one into a beneficial orbit?

When NASA's Dawn mission (6, 7) arrives at asteroid 4 Vesta in 2011, it will find a world with gigantic volcanic edifices and complex craters. Arriving at Ceres in 2015, it might find relics of vast hydrological systems. Only a handful, at best, of the hundreds of thousands of objects that orbit the Sun inside Jupiter's path have undergone this kind of planetary processing; the rest have been cold, battered objects since the solar system’s origin.

The first pictures of asteroids, obtained by spacecraft flybys in the 1990s (8, 9), were of objects at the large end of the scale, tens of kilometers, because only these at the time had the accurately determined orbits required for a successful flyby. Smaller, much more common bodies occasionally come close enough to Earth to be imaged by ground-based radar telescopes (10); radar technology has revealed a representative menagerie (11) with sizes ranging down to tens of meters. With Hayabusa’s arrival at Itokawa (dimensions ~0.5 by 0.2 by 0.3 km), we have visited the first small one, and perhaps the first typical one. It is a different kind of animal.

Most small asteroids have irregular shapes, and many rotate at the limit of flying apart (12, 13). A fifth of known asteroids have flung off sizable moons during collisions or close tidal passages (14). They are geologically quite odd. Moreover, their geological