



Bruce Alberts is Editor-in-Chief of *Science*.

Celebrating a Year of Science

IN THIS FINAL ISSUE OF THE YEAR, *SCIENCE* CONTINUES A TRADITION BY PRESENTING OUR selections for the 10 major scientific breakthroughs of 2008. At the top of the list: the rapidly expanding field of cell reprogramming, which began with a seminal discovery in 2006 and this year reached the stage where much new knowledge of both fundamental and applied significance is being harvested. And the runner-up: the first direct observations of planets orbiting distant Sun-like stars.

A planet 100 light years away is about 10^{15} kilometers from Earth, and a cell spans only about 10^{-5} meter. Thus, our top two breakthroughs of the year represent a difference of 10^{23} in scale, a breathtaking illustration of the tremendous reach of science.

The breakthroughs described on p. 1766 reveal other important aspects of science. One is the powerful way that new technologies promote its advance. The scientists who achieved each of this year's breakthroughs exploited techniques and instrumentation that were unimaginable when I began my life as a scientist in the 1960s. To mention only a few: computational speeds and methods, detectors, telescopes, DNA sequencers, and recombinant DNA technologies. These new technologies are created from the knowledge of the natural world generated by previous scientific and technical advances. Therefore, the more we know, the more we can discover, and the pace of scientific discovery constantly accelerates.

The breakthroughs also illustrate that in science, the unknowns are unending. It seems that there will always be mysteries to challenge scientists, because each new finding raises a new set of unanswered questions about the universe. For example, some investigators have recently been able to reprogram adult human cells in culture to produce cells that carry the alterations known to cause a variety of diseases. Others have been able to transform one type of adult cell to another in a living animal. But the conversion frequencies are very low (usually only 1 cell in 10,000 can be reprogrammed). Thus, embedded in the reprogramming breakthrough are critical new questions: What are the factors that currently limit cell reprogramming, and how can they be overcome so that large numbers of cells can be induced to reprogram, rather than a tiny minority?

And there are always surprises. As scientists develop sensitive tests to probe the properties of the reprogrammed cells derived from induced pluripotent stem cells, they are finding subtle differences from the same types of cells created by a more natural and controversial route from embryonic stem cells. These discoveries add new questions to the unending list of those that remain to be solved.

This year there was no contest for the top breakdown: the frightening financial meltdown. In the past decade, more than half of the graduates of Yale, Princeton, and Harvard who did not go directly to professional schools chose a career in the finance industry or in management consulting. It seems likely that this distribution will now change. Many more of our most talented young people may decide to tackle the urgent problems in energy, environment, health, and education—perhaps a silver lining on a very dark cloud.

On the very bright side, our breakthroughs provide wonderful examples of the beauty of scientific understandings. The physicist Richard Feynman had a gift for explaining this elegance. As he said, "The world looks so different after learning science. For example, trees are made of air, primarily. When they are burned, they go back to air, and in the flaming heat is released the flaming heat of the sun which was bound in to convert the air into tree . . . These things are beautiful things, and the content of science is wonderfully full of them. They are very inspiring, and they can be used to inspire others."

As you read about the new understandings gained in 2008, be inspired—in fact, you might try to envision each of them as a special form of poetry.

— Bruce Alberts

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