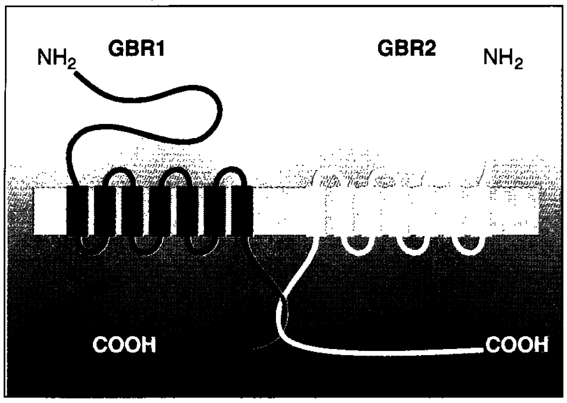
Bettler team, groups led by Hans-Christian Kornau of the biotech firm BASF-LYNX Bioscience AG in Heidelberg, Germany, and by Fiona Marshall at Glaxo Wellcome's Molecular Pharmacology unit in Stevenage, England, coaxed yeast cells to express the tail of GBR1. The tail was to serve as a bait for picking up any proteins that interact with it and might be needed for $GABA_B$ function. Both teams turned up the same protein, which Kornau dubbed GBR2. Like GBR1,



Together. Functional $GABA_B$ receptors require an interaction between the GBR1 and GBR2 proteins.

GBR2 turned out to contain seven hydrophobic regions that could thread through the lipid-rich cell membrane and two ends that could project inside and outside the cell. This structure suggested that GBR2 is also a receptor, and thus that two receptor molecules may operate as a duet in cells.

Meanwhile, the Novartis, Synaptic, and Glaxo teams were searching the GenBank human gene database for proteins resembling GBR1 in hopes of finding one that would do a better job of reproducing the $GABA_B$ receptor's functions. Remarkably, they all picked out the same protein that had popped up in the yeast. But when the researchers coaxed cultured cells to express GBR2, along with the requisite potassium channels, this receptor also failed to produce robust potassium currents in response to GABA treatment.

Thinking they had missed the active part of the $GABA_B$ receptor, the Synaptic team was about ready to give up when they looked at the expression patterns of both GBR1 and GBR2 in sections of rat brain, and noticed a striking overlap. This overlap, which the other scientific teams also saw, suggested that the two proteins may work together in individual neurons.

And that's what all the groups have now shown. When they expressed both GBR1 and GBR2 in cultured frog or human cells, the cells produced potassium currents. "It worked beautifully," says Jones. The Novartis group went one step further: Aided by specific antibodies, they demonstrated that the two proteins are closely associated on individual brain neurons. In addition, the Kornau group has mapped the site where the two proteins interact.

The BASF-LYNX group reports its findings on page 74; the other three papers appeared in the 17 December 1998 *Nature*. Together, the four papers suggest that GBR1 and GBR2 cooperate in at least two ways. First, the proteins are likely to help each other transmit GABA's signal within a neuron, allowing the neurotransmitter to activate the potassium channels. In addition, GBR2 may help shuttle GBR1 to its final location on the cell membrane, since the Glaxo team showed that GBR1 does not get to the membrane unless GBR2 is present.

Whatever the nature of the partnership, by providing a fully functional receptor, the discovery of GBR2 should help researchers design new drugs that work through $GABA_B$. Drugs that target $GABA_B$ might, for example, provide a new range of therapies that help depress the excessive neuronal firing characteristic of epilepsy, pain, and anxiety, or perhaps help relieve neuronal inhibition to bolster memory or ameliorate depression. As yet, however, nobody can predict how successful such drug development efforts will be. "We're still far from a direct clinical application," says Kornau, "but knowing this receptor's structure is a significant step forward."

—INGRID WICKELGREN

CREDITS: (LEFT) HANS-CHRISTIAN KORNAU; (RIGHT) RICK KOZAK

Moon-Forming Crash Is Likely in New Model

The greatest accident in Earth's history was probably no accident at all, according to new computer simulations of the early solar system. Planetary scientists believe that sometime in the first 100 million years after the solar system took shape from gas and dust, a Mars-sized planet smashed into Earth. The impact liquefied Earth's surface and ejected a huge blob of material that coalesced into the moon. Far from being a chance encounter that defied all the odds, the new simulations suggest, an impact like this is expected to occur in the solar system's first 100 million years.

"The lesson is that giant impacts are common," says Robin Canup of the Southwest Research Institute (SWRI) in Boulder, Colorado, who developed one of the models. "They're not the wild, ad hoc event that they were once believed to be." Her simulations,

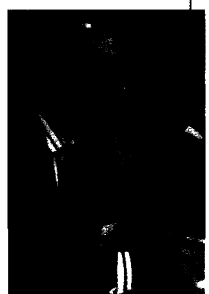
ScienceScope

A TIME FOR FORWARD THINKING

"I never think of the future—it comes soon enough," Albert Einstein once declared. But for those who don't share the great physicist's ambivalence about where time's arrow is taking us, we preview what may be some of 1999's science headlines:

Disposable Income? Expect to hear less grumbling among postdocs. Thanks in part to a $2 billion budget boost, the National Institutes of Health (NIH) will increase stipends for its postdoctoral fellows by up to 25% this year. A newly minted Ph.D. can expect an annual salary of $26,256, up from about $21,000 last year. Veterans with 7 or more years in the trenches will get $41,268.

You'll Know It When You See It A 2-year struggle to define scientific misconduct should end when a U.S. government panel releases guidelines this spring.



Gene Machine DNA sequencing virtuoso J. Craig Venter should know by autumn if his scheme for speed-reading the human genome will fly—or fizzle (*Science*, 15 May 1998, p. 994). Venter's corporate partner, Perkin-Elmer Corp., expects to begin delivering the project's key technology—several hundred speedy sequencers—to his Maryland headquarters in late spring. Test runs on fruit fly DNA should tell Venter if he's off to a soaring start—or grounded by technical snags.

Lucky 22 Meanwhile, other genome sequencers hope to have the first human chromosome—number 22—finished sometime before June. Keep up with the project's progress at www.sanger.ac.uk/HGP/Chr22

Take Me to Your Leader 1999 will be a soul-searching time for several pillars of the U.S. scientific establishment. The Howard Hughes Medical Institute is looking to name a new leader to guide the nation's largest private biomedical grants program. Also in play are the top slots at the Memorial Sloan-Kettering Cancer Center and *Science* magazine. Listen for whispers about Harold Varmus possibly giving up his director's chair at NIH.

CONTINUED ON PAGE 17

which were announced last month at the Origin of the Earth and Moon conference in Monterey, also tracked for the first time how smaller collisions following the giant impact could have tweaked Earth's rotation rate and the tilt of its axis to match what is seen today.

Don Davis and William Hartmann, now of the Planetary Science Institute in Tucson, Arizona, proposed the giant impact theory in 1975. By the mid-1980s, it had emerged as the leading explanation for the moon, largely because every other theory appeared to have fatal flaws. For example, "co-accretion," in which the Earth and moon grew up together, failed to explain why the moon has a much smaller iron core than Earth. The "fission" model, in which the moon spun off from the outer layers of Earth, failed to explain why the moon has an iron core at all. But planetary scientists embraced the impact scenario reluctantly, says Hartmann.

Big crash. Artist's conception of a Mars-sized body smashing into the infant Earth, a likely event in the early solar system.

"The big objection in those days was that a giant catastrophic collision seemed ad hoc to all the other workers."

Testing the idea by simulating the motion of the dozens of "protoplanets"—the building blocks of the planets—in the early solar system was impossible until recently. Computers weren't up to the task, and existing mathematical methods limited the length of time that could be modeled. After 100,000 orbits or so, the accumulated errors in the computations would cause the planets to fly away to infinity or spiral into the sun. Canup, Craig Agnor of the University of Colorado, Boulder, and Harold Levison of SWRI, however, use a new method called "symplectic integration," which prevents the energy of the virtual solar system from increasing, enabling researchers to model tens of millions of orbits.

Canup's simulations begin about 10 million years after the birth of the solar system, when gas and dust would have coalesced into about two dozen protoplanets, and continue until the full-fledged planets have settled into stable orbits, typically after about 100 million years. At this point, the inner solar system nearly always contains only four or five planets that have swept up all the rest. Usually, one or two of these planets have experienced impacts large enough to form a moon, Canup found. Two other research groups, relying on symplectic modeling techniques, have gotten similar results.

Planetary scientists agree that the new simulations are not the last word. "The problem with the simulations is that they are all primitive in one way or another," says Jack Lissauer of NASA's Ames Research Center in Mountain View, California, a member of one of the other modeling groups. In particular, all three models assume that colliding objects stick together like lumps of clay; in reality, many of the collisions probably threw out debris, affecting the size and orbit of the resulting body. (The new models don't actually show debris flying off to form the moon; they simply show impacts big enough to do the job.)

Still, Canup's simulation may resolve an inconsistency in the giant impact scenario: the difficulty of producing a collision large enough to get a moon-sized body into orbit, but with low enough angular momentum to produce the orbit seen today. Most plausible impacts would have resulted in a lunar orbit much farther out.

Earlier this year, Alastair Cameron of Harvard University proposed one solution. His model assumes the Earth was only two-thirds its present size when the impact occurred, allowing the impactor to be small and eliminating the angular momentum problem. If the collision took place early enough in planetary history, plenty of debris would have remained to feed the growth of Earth to its present size. But there's a snag: comparisons of the chemical compositions of the Earth and moon imply that the Earth was fully formed, or nearly so, when it spawned the moon.

Canup's simulations provide a different way out. They show that before or after the giant impact, Earth could have experienced a shower of small impacts, which could have slowed the rotation of the Earth-moon system. "Smaller impacts are very effective at tweaking the spin of a planet, even though they add very little mass," Canup says. Lissauer, however, is not convinced that Canup's solution escapes the problem of the similarity in Earth-moon composition, noting that his "back-of-the-envelope" calculation shows that the impactors would have added at least 4% of Earth's present mass after the moon had been born.

The new impact simulations also give astronomers who are searching other stars for planets like our own an extra tool. By making giant impacts a likelihood and smaller impacts a near certainty, the simulations suggest that the birth throes of moons like our own might be visible in other solar systems. Alan Stern of SWRI, who has calculated that a moon-forming impact should be detectable from a distance of 400 light-years, says the glow of such a cataclysm "would be the only way of detecting an Earth-sized planet in another solar system directly."

–DANA MACKENZIE

Dana Mackenzie is a writer in Santa Cruz, California.

HUMAN CLONING

Korean Report Sparks Anger and Inquiry

SEOUL, KOREA—Last month's report by doctors at a Seoul fertility clinic that they had cloned a human embryo has set off a storm of scientific doubts and public anger here. Announced on 14 December by a team from Kyunghee University Hospital, the procedure has also sent Korean politicians scrambling to fill a hole in rules adopted last year by the Ministry of Health and Social Welfare that cover genetic research but not human cloning.

A press release from the Kyunghee doctors described a procedure using cells donated by a patient, a woman in her 30's, for unspecified experimental purposes. The researchers say they removed the nucleus of an egg cell and inserted the nucleus of an adult cumulus cell—a kind of cell that surrounds the ovary—before chemically activating the new cell. The reconstituted egg cell then divided twice in vitro before the researchers ended the experiment.

Fertility specialists Kim Bo Sung and Lee Bo Yun, two members of the Kyunghee team, say they closely followed a technique used by University of Hawaii researchers to clone mice (*Nature*, 23 July 1998, p. 369). But they have declined to provide details and say that no results will be published until further work is done. Lee says he thought that pre-implantation stage research might be helpful in treating infertile couples, but that the team aborted the embryo after four cells because of ethical concerns.

Other scientists here have joined a global chorus of skepticism about these claims. They point out that it is common for ordinary unfertilized eggs to divide twice if stimulated and have derided the Kyunghee team for grandstanding. Seo Jung Sun, head of a four-man committee appointed by the Korean Medical Association to investigate

CREDIT: WILLIAM HARTMANN