

Science's Breakthrough of the Year: Watching evolution in action

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Evolution has been the foundation and guiding theory of biology since Darwin gave the theory its proper scientific debut in 1859. But Darwin probably never dreamed that researchers in 2005 would still be uncovering new details about the nuts and bolts of his theory -- how does evolution actually work in the world of influenza genes and chimpanzee genes and stickleback fish armor? Studies that follow evolution in action claim top honors as the Breakthrough of the Year, named by *Science* and its publisher AAAS, the nonprofit science society.

In 2005, scientists piled up new insights about evolution at the genetic level and the birth of species, including information that could help us lead healthier lives in the future. Ironically, these often-startling discoveries occurred in a year when backers of "intelligent design" and other opponents of evolution sought to renew challenges to this fundamental concept.

This milestone, plus nine other research advances, make up *Science*'s list of the top ten scientific developments in 2005, chosen for their profound implications for society and the advancement of science. *Science*'s Top Ten list appears in the 23 December 2005 issue of the journal *Science*.

Many of this year's breakthrough studies followed evolution at the genetic level. In October this year, an international team of researchers unveiled a map of the chimpanzee genome. Scientists are already poring over the chimpanzee genome and another international effort, the biggest map to date of single-letter variations in the human genetic

sequence, hoping to get a better glimpse of the human species' evolutionary history. The two studies give scientists new material for studying conditions from AIDS to heart disease, and may lay the groundwork for a future of personalized genetic medicine.

This year's sequencing of the 1918 pandemic flu virus could have a more immediate impact on medicine. The amazing story of flu genes preserved in permafrost and painstakingly reconstructed has a chilling coda: the deadly flu seems to have started out as purely a bird virus. Understanding the evolution of last century's deadly bird flu may help us predict and cope with the current bird flu threat.

Other studies showed how small changes in DNA can trigger dramatic evolutionary events. Researchers found that a single genetic change can be all it takes to turn one species into many, as in the case of the Alaskan stickleback fish that lost its armor and evolved from an ocean-loving species to a variety of landlocked lake dwellers.

Beyond the genome, researchers watched evolution in action among a number of animals, from caterpillars to crickets, and found that behavioral differences such as what to eat and when to mate may be enough to turn a single population into two species. These painstaking observations and other experiments showed that evolutionary studies are as relevant to 2005 as they were to 1859.

***Science* also salutes nine other scientific achievements of 2005.**

Planetary Safaris: With spacecraft at or on the way to the moon, Mercury, Venus, Mars, a comet, an asteroid, Saturn, and the very edge of the solar system, planetary discovery soared in 2005. The high point in a year of highlights may be the landing of the European spacecraft Huygens on Titan, Saturn's largest moon. Huygens' trip to Titan revealed a world where infrequent but drenching rains of liquid methane shape

the land and participate in a fascinating hydrologic cycle.

A Rich Year for Plants: Several key molecular cues behind flowering and other plant mysteries and surprises came to light in 2005. For example, plant molecular biologists pinned down the identity of a signal that initiates the seasonal development of flowers. Other research focused on a gene involved in stimulating flowering, and another study highlighted a surprising cache of RNA.

The Nature of Neutron Stars: In 2005, new instruments yielded vivid insights into the most violent behaviors of neutron stars. A short, intense pulse of radiation from near the center of the Milky Way, recorded on 27 December 2004, may be the result of a short gamma ray burst -- a rapid merger of two ancient neutron stars or a neutron star and a black hole.

Brain Wiring and Disease: Several studies in 2005 suggest that diseases such schizophrenia, Tourette syndrome, and dyslexia are rooted in "faulty wiring" of the brain's neural circuitry during development in the womb.

Where Did Earth Come From?: This year, researchers took another look at Earth rocks and meteorites that resemble the starting material of the solar system and found that their atoms were significantly different. So where did Earth get its building blocks? Some scientists now say early Earth materials come from a different part of the solar system, while others say parts of early Earth are just sunk deep in the planet, hidden from view.

Key Protein's Close-up: The most detailed molecular portrait to date of a voltage-gated potassium channel was unveiled in 2005. These channels, gatekeeper proteins that usher potassium ions in and out of cells, are as key to nerve and muscle functioning as transistors are to computers.

Changing Climate of Climate Change?: In 2005, evidence linking humans to global warming continued to accumulate and U.S. politicians began to take notice. From the warming of deep ocean waters and increased frequencies of the most intense tropical cyclones to continued reductions in ice cover in the Arctic Ocean and altered bird migratory patterns, scientific evidence for climate change built up in 2005 and non-scientists seem to have listened.

Cell Signaling Steps Up: Dynamic views of how cells respond to the chemical and environmental signals all around them took hold in 2005 thanks to efforts to track multiple inputs and outputs of cell signaling networks simultaneously. For example, researchers created a model of nearly 8,000 chemical signals involved in a network leading to programmed cell death.

ITER Lands in France: The struggle over the location of the world's first fusion reactor has ended -- the International Thermonuclear Experimental Reactor (ITER) will be built at Cadarache in southern France and not in Rokkasho, Japan. One aim of ITER is to generate fusion-powered electricity by recreating the power of the sun on Earth.

Science's Breakdown of the Year -- U.S. Particle Physics: With the cancellation of two major experiments and talk of an early closing for one of the three existing particle colliders, U.S. particle physics is Science's breakdown of 2005. As the U.S. program founders, particle physics research around the world could suffer. A bit of good particle physics news did emerge in 2005, however – researchers around the world remain committed to building the International Linear Collider, a multibillion-dollar global facility that may be the key to the future of particle physics.

Areas to watch in 2006: This year, Science's predictions for hot fields and topics in the upcoming year include drug and vaccine development

for avian flu, RNA-interference in humans, high-temperature superconductors, the microbial family tree, detection of the merging of two neutron stars and ultrahigh-energy cosmic rays – the speediest atomic nuclei in the universe. Researchers will also be on the lookout for more evidence for the ivory-billed woodpecker and solid helium flowing like a liquid.

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