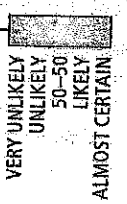
12 EVENTS that will change everything

KEY CONCEPTS

- Several events, both natural and man-made, can happen suddenly and at any time, completely transforming societies.
- Many of these events will not unfold the way popular conceptions have imagined they will.

—The Editors

How Likely?



This gauge marks the probability of the event occurring by the year 2050.

The best science transforms our conception of the universe and our place in it and helps us to understand and cope with changes beyond our control. Relativity, natural selection, germ theory, heliocentrism and other explanations of natural phenomena have remade our intellectual and cultural landscapes. The same holds true for inventions as diverse as the Internet, formal logic, agriculture and the wheel.

What dramatic new events are in store for humanity? Here we contemplate 12 possibilities and rate their likelihood of happening by 2050. Some will no doubt bring to mind long-standing dystopian visions: extinction-causing asteroid collisions, war-waging intelligent machines, Frankenstein's monster. Yet the best thinking today suggests that many events will not unfold as expected. In fact, a scenario could be seen as sobering and disappointing to one person and curious and uplifting to another. One thing is certain: they all have the power to forever reshape how we think about ourselves and how we live our lives.

—The Editors

PHOTOGRAPHS BY KEVIN VAN AELST

cloning of a human

The process is extremely difficult, but it also seems inevitable

By Charles Q. Choi

Ever since the birth of Dolly the sheep in 1996, human cloning for reproductive purposes has seemed inevitable. Notwithstanding past dubious claims of such an achievement—including one by a company backed by a UFO cult—no human clones have been made, other than those born naturally as identical twins. Despite success with other mammals, the process has proved much more difficult in humans—which may strike some people as comforting and others as disappointing.

Scientists generate clones by replacing the nucleus of an egg cell with that from another individual. They have cloned human embryos, but none

VOLUME 302, NO. 6

has yet successfully grown past the early stage where they are solid balls of cells known as morulas—the act of transferring the nucleus may disrupt the ability of chromosomes to align properly during cell division. "Whenever you clone a new species, there's a learning curve, and with humans it's a serious challenge getting enough good-quality egg cells to learn with," says Robert Lanza of Advanced Cell Technology in Worcester, Mass., who made headlines in 2001 for first cloning human embryos. Especially tricky steps include discovering the correct timing and mix of chemicals to properly reprogram the cell.

Even with practiced efforts, some 25 percent of cloned animals have overt problems, Lanza notes—minor slips during reprogramming, culturing or handling of the embryos can lead to developmental errors. Attempting to clone a human would be so risky, Lanza says, it "would be like sending a baby up into space in a rocket that has a 50–50 chance of blowing up."

Ethical issues would persist even assuming foolproof techniques. For instance, could people be cloned without their knowledge or consent? On the other hand, a clone might lead a fuller life, because it "really gets to learn" from the original, says molecular technologist George M. Church of Harvard Medical School. "Say, if I learned at 25 I had a terrific ear for music but never got music lessons, I could tell my twin to try it at 5."

The possibility of human cloning may not be restricted to *Homo sapiens*, either. Scientists may soon completely sequence the Neandertal genome. Although DNA is damaged during fossilization, an excellent fossil could yield enough molecules to generate a cloneable genome, Church suggests. Bringing a cloned extinct species to term in a modern species is even more challenging than normal cloning, considering that such factors as the womb environment and gestation period might be mismatched. The only clone so far of an extinct animal—the bucardo, a variety of ibex that died off in 2000—expired immediately after birth because of lung defects.

In the U.S., not all states have banned human reproductive cloning. The United Nations has adopted a nonbinding ban. If human cloning happens, it will "occur in a less restrictive area of the world—probably by some wealthy eccentric individual," Lanza conjectures. Will we recoil in horror or grow to accept cloning as we have in vitro fertilization? Certainly developing new ways to create life will force us to think about the responsibilities of wielding such immense scientific power.