



When Jeanne Calment died in a nursing home in southern France in 1997, she was 122 years old, the longest-living human ever documented. But Calment's uncommon status will fade in subsequent decades if the predictions of some biologists and demographers come true. Life-span extension in species from yeast to mice and extrapolation from life expectancy trends in humans have convinced a swath of scientists that humans will routinely coast beyond 100 or 110 years of age. (Today, 1 in 10,000 people in industrialized countries hold centenarian status.) Others say human life span may be far more limited. The elasticity found in other species might not apply to us. Furthermore, testing life-extension treatments in humans may be nearly impossible for practical and ethical reasons.

Just 2 or 3 decades ago, research on aging was a backwater. But when molecular biologists began hunting for ways to prolong life, they found that life span was remarkably pliable. Reducing the activity of an insulinlike receptor more than doubles the life span of worms to a startling—for them—6 weeks. Put certain strains of mice on near-starvation but nutrient-rich diets, and they live 50% longer than normal.

Some of these effects may not occur in other species. A worm's ability to enter a "dauer" state, which resembles hibernation, may be

critical, for example. And shorter-lived species such as worms and fruit flies, whose aging has been delayed the most, may be more susceptible to life-span manipulation. But successful approaches are converging on a few key areas: calorie restriction; reducing levels of insulinlike growth factor 1 (IGF-1), a protein; and preventing oxidative damage to the body's tissues.

How Much Can Human Life Span Be Extended

All three might be interconnected, but so far that hasn't been confirmed (although calorie-restricted animals have low levels of IGF-1).

Can these strategies help humans live longer? And how do we determine whether they will? Unlike drugs for cancer or heart disease, the benefits of antiaging treatments are fuzzier, making studies difficult to set up and to interpret. Safety is uncertain; calorie restriction reduces fertility in animals, and lab flies bred to live long can't compete with their wild counterparts. Furthermore, garnering results—particularly from younger volunteers, who may be likeliest to benefit because they've aged the least—will take so long that by the time results are in, those who began the study will be dead.

That hasn't stopped scientists, some of whom have founded companies, from searching for treatments to slow aging. One intriguing question is whether calorie restriction works in humans. It's being tested in primates, and the National Institute on Aging in Bethesda, Maryland, is funding short-term studies in people. Volunteers in those trials have been on a stringent diet for up to 1 year while researchers monitor their metabolism and other factors that could hint at how they're aging.

Insights could also come from genetic studies of centenarians, who may have inherited long life from their parents. Many scientists believe that average human life span has an inherent upper limit, although they don't agree on whether it's 85 or 100 or 150.

One abiding question in the antiaging world is what the goal of all this work ought to be. Overwhelmingly, scientists favor treatments that will slow aging and stave off age-

related diseases rather than simply extending life at its most decrepit. But even so, slowing aging could have profound social effects, upsetting actuarial tables and retirement plans.

Then there's the issue of fairness: If antiaging therapies become available, who will receive them? How much will they cost? Individuals may find they can stretch their life spans. But that may be tougher to achieve for whole populations, although many demographers believe that the average life span will continue to climb as it has consistently for decades. If that happens, much of the increase may come from less dramatic strategies, such as heart disease and cancer prevention, that could also make the end of a long life more bearable. —JENNIFER COUZIN

CREDIT: GETTY IMAGES

Is superfluidity possible in a solid? If so, how?

Despite hints in solid helium, nobody is sure whether a crystalline material can flow without resistance. If new types of experiments show that such outlandish behavior is possible, theorists would have to explain how.

Are there stable high-atomic-number elements?

A superheavy element with 184 neutrons and 114 protons should be relatively stable, if physicists can create it.

What is the structure of water?

Researchers continue to tussle over how many bonds each H₂O molecule makes with its nearest neighbors.



JUPITER IMAGES

What is the nature of the glassy state?

Molecules in a glass are arranged much like those in liquids but are more tightly packed. Where and why does liquid end and glass begin?

continued >>

Are there limits to rational chemical synthesis?

The larger synthetic molecules get, the harder it is to control their shapes and make enough copies of them to be useful. Chemists will need new tools to keep their creations growing.