Bristlecone pine

The oldest known tree in the world is bristlecone pine in California. It is about 5,070 years old. It is disputable if the tree will ever die from old age. Honestly, the whole concept of “dying from old age” is a bit misleading. No living thing, whether plant or animal, really dies of old age. When we say that a human dies of old age, it means that he or she passed away from one of the common diseases associated with aging like pneumonia, influenza, cancer, or liver failure. Dying from old age is not actually a scientifically recognized cause of death, there's always something more specific.

When animals grow older, their cells may cease to divide, or the division process may grow increasingly sloppy, leading to deleterious mistakes. On the outside, this aging process shows through cognitive decline, or wrinkles in humans.

While it's not precisely known whether or not individual trees are biologically immortal, they definitely don't grow old the same way animals do. Bristlecone pine trees grow indeterminately, meaning that with the right conditions, they can grow and grow and grow, with only the laws of physics limiting their height. (There's a certain point where a tree cannot send enough water from the roots to the top layer of leaves, preventing adequate photosynthesis.) Amazingly, once they hit that maximum height, instead of growing taller, they grow wider! And they do so at an ever-increasing rate! That's right, trees actually grow faster as they age.

The secret to their perpetual growth has already been revealed. Most plant cells are perpetually embryonic, meaning they can change into another cell type at any time.

So if trees never stop growing, why aren't there more trees that are hundreds of thousands of years old, or even millions of years old?
The longer a tree is around the more opportunities it has to have something happen to it that leads to its death. This could be a lot of different things such as a storm, a disease, an insect infestation. Often a tree can survive numerous instances of potential death, but over time these instances can aggregate, or lead to a greater susceptibility to death. For example, a storm might knock off a tree limb, which might give the tree a higher risk of exposure to a disease.

So a tree may not die of old age, but after a long enough time, simple statistics dictate that it will die of some other cause.

adapted from Do Trees Die of Old Age? | RealClearScience

Hydra

Hydra are aquatic animals. They are freshwater creatures, or polyps, from 10 mm to 30 mm long. They belong to the phylum *Cnidaria*, a group of symmetrical invertebrates that includes jellyfish, sea anemones and corals. They look like tiny tubes with tentacles protruding off one end and they eat even tinier aquatic animals.The hydra is best-known for its unusual ability to regenerate parts of its body, making the creature biologically immortal.

Hydra are known for their regenerative capabilities. Most of their body cells are stem cells. These cells are capable of continuous division and differentiation into any cell type in the body. Hydra constantly renew their bodies with fresh cells. A hydra's regenerative abilities allow it to constantly replace bits of itself, so it doesn't succumb to things like old age or disease. Constant regeneration means a hydra never loses its body parts. Give it a few days and it will grow back anything, even its lost head.

Dr. Mortazavi, a developmental biologist at the University of California, and his colleagues have taken a big step in understanding how a hydra regenerates its head.
The researchers looked at changes in gene expression — whether a gene is copied from DNA into RNA — throughout the course of hydra head regeneration. This control of gene expression is called epigenetic regulation. Hydras have a genome quite similar to that of species with little regenerative capacity, like humans, so it's thought that epigenetic regulation plays a major role in making the hydra's powers of regeneration possible.

The team discovered dynamic alterations in the regulation of stretches of DNA called enhancers. Enhancers increase the likelihood that a related gene will be copied from DNA into RNA. These enhancers were helping to ensure the expression of many genes including those long known to be important for regeneration. "Nobody knew hydras had these enhancer regions," said Dr. Mortazavi.

These findings serve as a reminder of the importance of studying ancient creatures like hydras. They are really in a prime position for answering a lot of very fundamental questions in developmental biology.

This kind of work is also essential for the regenerative medicine field, where a common goal is to restore diseased and injured tissues or even whole organs.

adapted from:
Hydra DNA Reveals There's More Than One Way to Regrow a Head - The New York Times

Welwitschia

The plant can be found only in the harsh, hyperarid desert between Angola and Namibia. In Afrikaans, the plant is named “tweeblaarkanniedood,” which means “two leaves that cannot die.” The naming is apt: Welwitschia grows only two leaves in a lifetime that can last millennia. It is known that it is capable of resisting for thousands of years in extremely harsh conditions, making it the longest-lived plant on the planet.

This plant can live thousands of years, and it never stops growing. When it does stop growing, it’s dead. Some of the largest Welwitschia plants are believed to be over 3,000 years old, with two leaves steadily growing since the beginning of the Iron Age.

Since it was first discovered, Welwitschia has captivated biologists including Charles Darwin. In a study published in 2021 researchers report some of the genetic secrets behind Welwitschia’s unique shape, extreme longevity and profound resilience.

The genetic analysis revealed that the plant can activate certain proteins to protect itself from the extreme conditions in which it lives, and it has a slow but sustained growth throughout its life.
Welwitschia's genome analysis showed that this plant has all its genes in double dose, what experts call "genetic redundancy". Approximately 86 million years ago, during a period of pronounced aridity and prolonged drought in the region, extreme stress caused an error in the plant's cell division that caused its entire genome to be duplicated. Extreme stress is often associated with such genome duplication. Duplicate copies can take over new functions and do new things that would be impossible if there was only one version of the gene.

However, having more genetic material comes with a cost. The most basic activity for life is DNA replication, so if you have a big genome, it is really energy consuming to maintain life, especially in such a harsh environment.
To make matters worse, a large amount of Welwitschia's genome is "junk" self-replicating DNA sequences called retrotransposons. Now that junk needs to be replicated and repaired.

But to counteract this, the Welwitschia genome underwent widespread epigenetic changes that silenced these useless junk DNA sequences, through a process called DNA methylation.

This process gave Welwitschia an extremely efficient and low-cost genome, allowing absurdly high longevity.

The most important thing is that the genetic lessons from Welwitschia may become the key to developing genetic varieties of plants that can withstand extreme climates in the future. This means that by replicating the plant's genome changes in varieties such as soya and maize, we will be able to create plants that are extremely resilient to climate change.

adapted from:

A Plant That 'Cannot Die' Reveals Its Genetic Secrets - The New York Times

An immortal plant could completely change the future of agriculture