Ötzi the Iceman: What we know 30 years after his discovery

Considered "Europe’s most famous mummy," the remains of the man who was murdered in the Alps 5,000 years ago continue to reveal details of Neolithic life—and insights into modern health.

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Thirty years ago this month, [Europe’s most famous mummy was discovered](https://www.iceman.it/en/the-discovery/) lying face-down in the ice, on the edge of a lake nearly two miles high in the Ötztal Alps bordering Austria and Italy.

Naturally preserved by more than 5,000 years of sun, wind, and freezing temperatures, the leathery remains of Ötzi the Iceman quickly became a global sensation, the subject of countless books and documentaries and even a [feature film reconstructing his life in Neolithic Europe](https://variety.com/2017/film/reviews/iceman-review-1202523730/) and his violent death.

Today, Ötzi is carefully tended to by researchers at the [South Tyrol Museum of Archaeology](https://www.iceman.it/en/) in Bolzano, Italy, where his wizened body is kept in a custom cold chamber maintained at a constant temperature of –21.2 degrees Fahrenheit. Four or five times a year, his remains are sprayed with sterile water to create an icy, protective exoskeleton that ensures he stays a “[wet mummy](https://www.iceman.it/en/the-mummy/)” (one naturally preserved in a wet rather than dry environment).

[*Go behind the scenes of Ötzi’s 2010 autopsy.*](https://www.nationalgeographic.com/magazine/article/iceman-autopsy)

In an average year, about 300,000 visitors travel to Bolzano to marvel at the ancient Iceman through a thick glass window that affords a view into his frosty chamber. Ötzi is equally in demand by scientists, who jump at the rare opportunity to study the incredibly well-preserved remains of a man who lived long before the rise of Europe’s earliest cities, and even before Egypt’s first pyramid was built.

“Ötzi is, in my eyes, the best investigated human body the whole world has ever seen,” says [Oliver Peschel](https://www.researchgate.net/scientific-contributions/Oliver-Peschel-38739877), the Munich-based forensic pathologist in charge of Ötzi’s conservation.

Here’s what three decades of research have revealed about the life and death of the Iceman—and what the future study of his extraordinary remains may reveal.

WHO WAS ÖTZI?

Ötzi was wiry, short (5’2”), and about 46 years old when he died. He was left-handed and wore a U.S. men’s size 8 shoe. His eyes—still preserved in their sockets—were long thought to be blue, but genomic analysis has revealed otherwise. “We could prove he had brown eyes and dark brown hair, and he had a typical Mediterranean skin tone,” says [Albert Zink](https://www.eurac.edu/en/people/albert-zink), head of the [EURAC Institute of Mummy Studies](https://www.eurac.edu/en/institutes-centers/institute-for-mummy-studies) in Bolzano, which has done much of the core research on Ötzi.

The Iceman had type O blood, was lactose intolerant, and had a rare genetic anomaly that prevented his 12th pair of ribs from forming. He suffered from cavities, intestinal parasites, Lyme disease, and sore knees, hips, shoulders, and back. His 61 tattoos map onto the places where his bones and joints show wear and tear (as well as onto modern acupuncture points). Ötzi had broken several ribs and his nose during his lifetime, and horizontal grooves on his fingernails indicate had repeated bouts of physical stress—[likely stemming from malnutrition](https://link.springer.com/content/pdf/10.1007/978-981-15-1614-6_19-1.pdf)—in the few months before his death. He was genetically predisposed to arteriosclerosis, and a CT scan confirms that his is the oldest known case of heart disease in the world.

Based on carbon dating, Ötzi lived roughly 5,200 years ago (3350–3110 B.C.)

WHO WERE HIS PEOPLE?

Based on his DNA signature, Ötzi was part of the migration of Neolithic farmers that came through Anatolia (modern Turkey) 8,000 to 6,000 years ago, replacing Europe’s Paleolithic hunters and gatherers. His maternal genetic heritage no longer exists in modern populations, but his paternal line lives on in groups found on Mediterranean islands, especially Sardinia.

WHAT HE WORE

Ötzi was found wearing only a single shoe, but many of his belongings were subsequently recovered around the site where he was found. His leggings and coats—one lighter, one heavier—were pieced together from the hides of local sheep and goats. His shoes were stuffed with wild grass and laced with auroch leather. His fur hat was from a brown bear.

WHAT HE CARRIED

The Iceman trekked through the Ötztal Alps with a wood-frame backpack and a [deerskin quiver with 20 arrow shafts](https://www.iceman.it/en/equipment/), only two of which had arrowheads. His flint dagger was sharpened with a tool fashioned from lime tree wood and a fire-hardened antler tip. A birch bark container, similar to those still made in the region today, held smoldering charcoal wrapped in fresh maple leaves that would’ve allowed him to quickly make a fire.

One of the most important objects is Ötzi’s sublime copper axe. Secured to a yew handle with cow leather and birch tar, the blade was cast from a mold and is 99.7 percent pure copper. It was an extraordinarily wealthy item for the time, and its discovery pushed back the beginning of the [European Copper Age](https://www.britannica.com/topic/history-of-Europe/The-Metal-Ages) by a thousand years.

HIS LAST MEAL

In the hours before his death, Ötzi had a hearty meal of einkorn wheat, red deer, and ibex. It took researchers 18 years to identify his stomach—via a 2009 CT scan—because the organ had shifted under his ribs to where his lower lungs are located.

HIS DEATH

A gash between the thumb and first finger of his right hand revealed that Ötzi had been stabbed a few days before he died. It was an active defensive wound, meaning he likely tried to grab the blade. That wound was still healing when he was attacked again with an arrow that hit an artery in his back left shoulder. He may have had time to sit down and perhaps try to pull the arrow out, but it’s unlikely he could have reached it before he bled to death within minutes.

The Iceman also had substantial brain hemorrhaging, but experts disagree about its cause. Did someone finish him off with a blow to the head? Did he fall and hit his head on a rock? Peschel says he doesn’t see good evidence for either of these scenarios.

HOW ÖTZI WAS NATURALLY MUMMIFIED

Based on analysis of pollen and the maple leaves he carried, Ötzi [died in early summer](https://www.iceman.it/en/the-mummy/#death). One theory posits that [warm summer winds dried him out](https://onlinelibrary.wiley.com/doi/abs/10.1002/(SICI)1096-8644(200002)111:2%3C211::AID-AJPA7%3E3.0.CO;2-M). But Peschel says it had to have been the frigid temperatures of the high mountain pass that preserved the Iceman, because his brain, which would usually liquify along with other organs a few days after death, froze quickly, preserving it in desiccated form.

WHAT HIS GUT SAYS

While hundreds of studies have already been done on Ötzi, more are in the works. Now that the Institute for Mummy Studies has sequenced Ötzi’s genome, they’re genetically analyzing his gut microbiome. “We would like to understand the whole community of bacteria that lived inside his stomach and his intestines,” says Zink.

The diversity of [our gut flora appears linked to our health](https://www.nationalgeographic.com/magazine/article/how-trillions-of-microbes-affect-every-stage-of-our-life-from-birth-to-old-age-feature), so researchers are keen to see the makeup of Ötzi’s. One early find, part of an [ongoing study](https://www.sciencedaily.com/releases/2019/10/191018112136.htm) by the University of Trento involving Ötzi and 6,500 modern people, reveals that the Iceman had three of the four strains of the bacterium *Prevotella copri*. Indigenous people around the world have a variety of strains of the bacterium in their gut, but the 30 percent of modern Westerners with *P. copri* have just one, which tends to take over, reducing diversity.

Another discovery is that Ötzi’s gut contained *Helicobacter pylori*, a bacterium found today in half of the world’s population, with severe or deadly health consequences for about 10 percent of us. The dominant strain of *H. pylori* in Europe today is a hybrid of Asian and African strains. Ötzi’s strain is nearly purely Asian, which suggests the African strain arrived in Europe after his death. This has implications for the debate over whether *H. pylori* is a natural member of our gut flora or needs to be treated with an antibiotic as soon as it’s identified.

Another [microbiome study of his gut](https://microbiomejournal.biomedcentral.com/articles/10.1186/s40168-016-0221-y#Sec26) found the pathogenic ancestor strain of *Clostridium perfringens*, today a common cause of food poisoning.

A BETTER, GREENER ÖTZI

The city of Bolzano plans to build a new archaeology museum in the next few years to house both Ötzi and a richer collection of Tyrolean artifacts. They also hope to improve the energy efficiency of the 22-year-old cold chamber system that supports his remains. (A second backup chamber is also on standby in case the primary one fails.)

IMITATING NATURE

To better understand the natural processes that have preserved Ötzi over five millennia—particularly exposure to the elements and the actions of microbes—researchers at the Institute of Mummy Studies are now [analyzing the naturally preserved remains of a chamois](https://www.sciencedaily.com/releases/2020/09/200903132958.htm), a kind of goat-antelope, discovered in summer 2020 in the same region as Ötzi. Though only a few hundred years old, its state of preservation is similar to the Iceman’s, and scientists are varying the humidity and temperature the animal’s remains are stored at to better understand how those factors impact preservation. They’re also studying its microbial community, both inside and out. “We know there are bacteria and fungi that can survive the cold temperatures, so maybe if you change something, they can start to grow again,” Zink says.

THE UNIMAGINABLE RESEARCH OF 2050

Technological advances will be key to unlocking more of Ötzi’s secrets—and are likely. [His 5,000-year-old genome was decoded in 2012](https://www.nature.com/articles/ncomms1701), just as next-generation sequencing was becoming more common and affordable. But even then, Zink says he never would have expected that one day researchers could also reconstruct the Iceman’s microbiome. “These methods developed so quickly, and now we get so much more data,” he marvels.

Future research could focus on the functionality of Özti’s body, including proteins, lipids, and enzymes found in his tissues that may reveal information about his immune system. For now, however, protein analysis of ancient samples remains a very complex process.

In the meantime, Ötzi’s caretakers have to strike a careful balance between making the mummy available for research and ensuring that research isn’t too invasive or frequent. The museum receives about 10 to 15 requests to study Ötzi every year. A committee of experts from various universities and the museum evaluates each request. About once a year they take surface samples for microbiology investigations. They only rarely defrost him. The last time was in 2019.

“We won't have any idea what scientific methods scientists in 2050 will have,” says Peschel. “It makes a lot of sense to keep Ötzi in the best condition to make research possible in 20, 30 years.”

