Mapping DNA of over 1 million species could lead to new medicines, other solutions to human problems

Earth BioGenome Project coordinated at ASU aims to improve human lives, protect biodiversity and transform the scientific understanding of all life on our planet

By Joe Rojas-Burke, ASU News
March 5, 2025

Valuable secrets await discovery in the DNA of Earth's millions of species, most of them only sketchily understood. Waiting to be revealed in the diversity of life's genetic material are targets for new medicines to combat cancer and other diseases, food crop genes for improving farming, new "biomaterials" for manufacturing and genetic resources to rebuild threatened ecosystems.

About the story

There's a reason research matters. It creates technologies, medicines and other solutions to the biggest challenges we face. It touches your life in numerous ways every day, from the roads you drive on to the phone in your pocket.

Six years ago, scientists around the world launched an ambitious project to map the DNA of all the animals, plants, fungi and other organisms with complex cells — all the eukaryotic life that exists on the planet.

The Earth BioGenome Project — a collaborative, international effort coordinated at Arizona State University — is on schedule to fully sequence the genetic material of 10,000 species by 2026, the project's Phase 1 goal.

"The project surpassed one of its early milestones: completing over 3,000 genomes across the tree of life," says co-founder Harris Lewin, who joined ASU's Julie Ann Wrigley Global Futures Laboratory in 2023. "It's really exploding. New collaborations are starting almost monthly with new sources of funding."

If successful, the massive DNA sequencing project will yield enormous benefits for people and the planet. Historically, the discovery of hundreds of medicines came from compounds produced by plants and animals. Knowledge gained from the study of yeast genes has led to improved production strains for making wine, beer and bread. Plants are foundational in industries such as food, rubber and bioethanol production. Sequencing and studying the vast number of uncharacterized genomes will drive the discovery of many new useful genes, proteins and the know-how to produce valuable bioproducts at industrial scale.

The ASU research in this article was possible only because of the longstanding agreement between the U.S. government and America's research universities. That compact provides that universities would not only undertake the research but would also build the necessary infrastructure in exchange for grants from the government.

That agreement and all the economic and societal benefits that come from such research have recently been put at risk.

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The complete and detailed genetic map of the eukaryotic tree of life should make it possible to answer questions about the origin and diversification of life as we know it, uncover fundamental laws that drive the evolution of species, and understand how ecosystems emerge and function.

"We need to move as quickly as we can, because if species that comprise critical ecosystems are lost, they may never be recovered again," Lewin says.

DNA, the double-helix molecule, carries the genetic information passed from parents to offspring. The information is written in genes in the form of long sequences of chemical bases best known by the first letters of their chemical names: A, T, C, and G. Whole-genome sequencing is a way of reading the order of these letters in all the genes that make up the inheritance of a species.

The Human Genome Project that was launched in 1990 took 13 years and more than $3 billion to sequence the 3 billion bases in the DNA of one species. When Lewin and colleagues announced the Earth BioGenome Project, they predicted it would cost $4.7 billion and take 10 years to sequence the genomes of 1.8 million species, all of the known life on Earth excluding bacteria and archaea, the life-forms that evolved without a cell nucleus.

Experience has made clear that the task is going to take longer than 10 years, but it's costing far less than predicted thanks to advances in DNA sequencing technology.

"A few thousand dollars is all that's needed to produce a reference-quality genome, and that cost is going down very fast," Lewin says.

The first phase is expected to cost $265 million, which is less than half the initial estimate.

"And we have enough money to finish Phase 1," Lewin says, with awards secured from the European Union, several individual countries, philanthropies and other sources.

The Earth BioGenome Project is an international coalition of scientists who are running more than 50 projects, and each group raises its own funding. These project leaders coordinate and work together with common standards for collection of samples and descriptive metadata, and for the performance and quality standards of DNA sequencing.

ASU houses a critical asset for advancing the Earth BioGenome Project: a national biorepository in partnership with the National Ecological Observatory Network. The biorepository holds more than 800,000 biological samples collected from 81 field sites across the U.S. Most are kept at the ASU Biocollections in Tempe, where they are available for DNA sequencing along with detailed data on each species and where it was collected.

As part of the Earth BioGenome Project, several researchers at ASU are focusing on life in desert ecosystems. They aim to sequence the genomes of 10 to 20 species and glean insights into their adaptations to heat and water scarcity, and the impacts of climate change.

Joining the effort are Anthony Barley in the School of Mathematical and Natural Sciences, and Nathan Upham, Jeremy Wideman, Krystal Tsosie and Beckett Sterner in the School of Life Sciences. They plan to begin sequencing work this summer and expect to have the first genome sequence completed by the end of 2025.

This story originally appeared on ASU News.

Main image

The Earth BioGenome Project seeks discoveries in the genes of species such as sea slugs, which produce an arsenal of natural compounds that have potential as drugs against cancer, infections, parasites and neurodegenerative diseases. Photo by Federico Stefanelli CC BY-NC 4.0 https://creativecommons.org/licenses/by-nc/4.0/